This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

THE

Mineralogical Magazine

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

VOLUME VII.

LONDON:
SIMPKIN, MARSHALL & Co., STATIONERS' HALL COURT.

MDCCCLXXXVII.

Digitized by Google

214664

LONDON:
PRINTED BY WILLIAMS AND STRAHAN,
LAWRENCE LANE, CHEAPSIDE.

Digitized by Google

TABLE OF CONTENTS.

PAGE

On a Glaucophane-eclogite from the Val d' Aoste. By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., Pres.G.S., &c. (A Plate.) ... 1

On Idocrase and other Minerals recently found near Zermatt. By W. J. Lewis, Professor of Mineralogy in the University of Cambridge 9

Orthoclase from Kilima-njaro, and Adularia from Switzerland. By H. A. Miers, M.A. (Four Woodcuts.) 10

On the Nomenclature of the Hydrocarbon Compounds, with a suggestion for a new classification. By Andrew Taylor, F.C.S. 13

The Metallic Ores of Chili. By John F. Kerr, F.G.S.E. (Communicated by Prof. Ivison Macadam.) 18

New Localities for the Mineral Agalmatolite, with Notes on its Composition. By William Hamilton Bell, F.G.S.E. 24

On a New Locality for Agalmatolite. By W. Ivison Macadam, F.C.S., F.I.C., &c., Professor of Chemistry, New Veterinary College, Edinburgh 29

On some New Localities for the Mineral Diatomite, with Notes on the Cnemical Composition of the Specimens exhibited. By W. Ivison Macadam, F.C.S., F.I.C., Professor of Chemistry, New Veterinary College, Edinburgh, &c. 30

Diatomaceous Deposits in Skye. By J. S. Grant Wilson, H.M. Geological Survey, and W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, and Lecturer on Chemistry, School of Medicine, Edinburgh 35

On the Chemical Composition of the Mineral Bruiachite, found by Mr. Thomas D. Wallace, of Inverness, at Loch Bhruithaich, Inverness-shire. By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh... 42

Abstracts and Notes 43

Barytes from Addiewell, West Calder, in Midlothian. By Charles O. Trechmann, Ph.D., F.G.S. (One Woodcut.) 49

Francolite, a Variety of Apatite from Levant Mine, St. Just, Cornwall. By R. H. Solly, F.G.S., Demonstrator in Mineralogy to the University of Cambridge 57

Digitized by Google

PAGE

Two Analyses of Crystals of Apatite. By Henry Robinson, M.A., Downing College, Cambridge 59

Anglesite from Portugal. By R. H. Solly, F.G.S., Demonstrator in Mineralogy to the University of Cambridge. (One Woodcut.) 61

On Plattnerite. By Edward Kinch, Professor of Chemistry, Royal Agricultural College, Cirencester 63

On a New Variety of Mineral from Cornwall. By Prof. E. Kinch, F.C.S., F.I.C., and F. H. Butler, M.A., A.R.S.M. With a Note on the Crystallographical Characters. By H. A. Miers, M.A., &c. 65

Cassiterite of the Straits Settlements. By J. H. Hampton ... 71

On the Occurrence of considerable Deposits of Limonite (Bog Iron Ore) in North-west Ross-shire. By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh... 72

Further Notes on Agalmatolite in Gairloch Parish, Ross-shire. By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh 74

On the Analysis of a Sample of Talc used in Paper-making. By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh 75

Analyses of Samples of China Clay (Kaolinite), Cornwall. By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh 76

Note on the Identification of the Scotch and New Brunswick "Albertites." By the Rev. D. Honeyman, D.C.L,, F.R.S.C., Curator of the Provincial Museum, Halifax, Nova Scotia ... 77

Note on Schorlaceous Rocks from near St. Austell. By F. H. Butler, M.A., A.R.S.M. 79

On the Relations between the Solution-planes of Crystals and those of Secondary Twinning; and on the Mode of Development of Negative Crystals along the former. A Contribution to the Theory of Schillerization. By Prof. John W. Judd, F.R.S., P.G.S. 81

Index to Mineralogical Papers, &c. 1885. By H. A. Miers, M.A. 93

Abstracts 114

Review 118

On a Meteoric Iron found in 1884 in the Sub-district of Youndegin, Western Australia, and containing Cliftonite, a cubic form of Graphitic Carbon. By L. Fletcher, M.A., F.C.S., President 121

Digitized by Google

PAGE

Supplementary Note on Felspar from Kilima-njaro. By L. Fletcher, M.A., F.C.S., and H. A. Miers, M.A., F.G.S., of the Mineral Department, British Museum 131

On the Occurrence of Greenockite at a New Locality. By Prof. Heddle, F.R.S.E., &c. (Five Woodcuts.) 133

On a Form of Calcite from Heilim, Sutherland. By Prof. Heddle, F.R.S.E., &c. (One Woodcut.) 138

Note on the Occurrence of Bismutite in the Transvaal. By Henry Louis, A.R.S.M., F.I.C., &c. 139

Apatite from a New Locality in Eastern Cornwall. By R. H. Solly, F.G.S., Demonstrator in Mineralogy to the University of Cambridge 141

Celestine from a New Locality in Gloucestershire. By R. H. Solly, F.G.S., Demonstrator in Mineralogy to the University of Cambridge 142

Note on the presence of Lead in Calcites from the Leadhills District. By J. Stuart Thomson, Esq. 148

On the Use of the Gnomonic Projection; with a Projection of the Forms of Red Silver Ore. By H. A. Miers, M.A. (Four Woodcuts and a Plate.) 145

Note on some Specimens of Glaucophane-rock from the Ile de Groix. By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S. ... 150

Notes on the Microscopical Structure of some Eruptive Rocks from Armenia and the Caucasus. By Hjalmar Gylling, Helsingfors. (Six Woodcuts.) 155

On Granite containing Andalusite from the Cheesewring, Cornwall. By J. J. H. Teall, M.A., F.G.S. 161

Note on Francolite. By F. H. Butler, M.A., A.R.S.M. 164

Abstracts 165

On a Meteoric Iron seen to fall in the District of Nejed, Central Arabia, in the year 1863. By L. Fletcher, M.A., F.C.S., President; Keeper of Minerals, British Museum; late Fellow of University College, Oxford 179

On a Meteoric Iron (containing Crystallised Chromite) found about the year 1880 in Greenbrier County, West Virginia, U.S.A. By L. Fletcher, M.A., F.C.S., President; Keeper of Minerals, British Museum; late Fellow of University College, Oxford ... 183

On Crystals of Cuprite and Cerussite resulting from the slow alteration of buried Coins. By L. Fletcher, M.A., F.C.S., President. 187

Digitized by Google

PAGE

On the Crystalline Form of Creatine. By L. Fletcher, M.A., F.C.S., President. (One Woodcut.) 189

On a Variety of Glaucophane from the Val Chisone (Cottian Alps). By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S. ... 191

On the Discovery of Leucite in Australia. By Prof. J. W. Judd, F.R.S., Pres.G.S. 194

On a Specimen of Proustite containing Antimony. By H. A. Miers, M.A., F.G.S., and G. T. Prior, B.A. 196

On the Occurrence of Rutile-needles in Clays. By J. J. H. Teall, M.A., F.G.S. 201

On the Nature and Origin of Clays: the Composition of Kaolinite. By J. H. Collins, F.G.S. 205

Note on the Occurrence of what may prove to be a new Mineral Resin. By J. Stuart Thomson 215

Obituary Notice of E. H. Furuhjelm 216

Abstracts 218

Index to Mineralogical Papers, &c. 1886. By H. A. Miers, M.A. 238

Digitized by Google

ERRATUM.

Page 77, line 2, *ab infra*, for "Gerner" *read* "Gesner."

Digitized by Google

Digitized by Google

THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

No. 32. JULY 1886. Vol. VII.

On a Glaucophane-eclogite from the Val d'Aoste.

By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., Pres. G. S., &c.

Plate I.

[Read December 8th, 1885.]

THE number of localities at which glaucophane has been discovered is still comparatively small, so that it may be of interest to add another and to describe the microscopic structure of a rock in which this interesting variety of hornblende occurs.

The carriage road between Verrex and St. Vincent in the Val d' Aoste mounts along the left bank of the Dora Baltea, which, in one part, often called the defile of Mont Jovet, is scarped and craggy. The steepest part of the ascent is between the hamlets of Berrioz and Nus (?). I was walking up this, one day in July 1885, in company with my friend the Rev. E. Hill, F.G.S., when my eye fell upon a rock, which I at once recognised as a variety of eclogite, composed chiefly of small reddish garnets and dull-green hornblende. We secured specimens, though with considerable difficulty, for the rock was very tough; made a few observations and passed on. Next morning, as I was preparing to pack up my specimen, I noticed a peculiar violet-blue tint on its surface, which in certain positions became

Digitized by Google

very marked. Probably the glittering dispersion caused by the strong sunlight had been the reason of my overlooking the colour on the previous afternoon. I at once felt certain that the tint indicated the presence of glaucophane, and on my return to England lost no time in having slices prepared for microscopic examination, which showed that mineral to be present in no small quantity.

The rock has a slightly foliated structure and a rather rough fracture. The garnets (which project on slightly weathered surfaces) commonly vary from about the size of a hemp seed to that of a mustard seed, but are occasionally a little larger or smaller. Their outline is not very sharply defined, their colour a plum-red or brownish-red. The (dominant) hornblendic constituent appears to be very slightly fibrous in texture, and to be an intimate mixture of a dull-green variety and one of a violet blue, inclining very slightly towards cobalt-blue; the prevalent colouring depending to some extent on the angle at which light is incident, and the blue tint being much more conspicuous on the freshly fractured surfaces. Besides this there is a fair amount of yellow-green epidote, more conspicuous on slightly weathered surfaces; and some scales of a silvery white mica. Examination with a lens shows also some tiny streaks of a minutely granular mineral, of a reddish brown colour, but paler than the garnet.

The following is a microscopic description of the rock, of which I have had six slides prepared from fragments taken from two different parts of the mass.

(1.) *Garnet.* Size commonly less than ·1 in. in diameter. The mineral is granular in outline, an external angle being seldom well-defined; much cracked, and showing occasional cleavage. Colour a pale wine-red. Minute microlithic enclosures not unfrequent; sometimes of glaucophane or hornblende, often of dark dust. It is, however, possible in certain cases that these are subsequent infiltrations.

(2.) *Hornblende.* On the whole the most abundant mineral, occurring in rather small, somewhat elongated crystals, in clustered groups, with a general uniformity of position, as if the mineral were a secondary formation developed under a pressure definite in direction. The crystals very often do not exhibit cleavage, and are not markedly dichroic. A distinct green in colour.

(3.) *Glaucophane.* The grains vary in external form, sometimes they are filmy and irregular in outline, sometimes the external faces are well defined. The former are interstitial with other minerals; the latter, though occasionally interrupted by a garnet, are often perfectly regular, as though developed

Digitized by Google

in a yielding matrix. Usually they are fairly free from inclusions, though sometimes they contain films of a chlorite or a more normal hornblende, or (more frequently) granules of a brown mineral to be described presently. The longitudinal sections of the glaucophane are often from ·04 to ·06 inch long, the transverse sections about ·03 inch. The cleavage parallel to ∞P is often very well defined, but the mineral has sometimes a slightly fibrous structure in longitudinal sections. With transmitted light the colour varies from a beautiful tint of violet-blue in longitudinal sections to a pale violet in tranverse sections. With polarised light the glaucophane, in longitudinal sections, with vibrations parallel to the *c* axis, gives a clear ultramarine blue, and, with perpendicular vibrations, a pale purplish or puce tint. In transverse sections, with vibrations parallel to the clino-diagonal plane it gives a pale, but slightly ruddy, sap-green, and, with vibrations perpendicular to it, a rich violet. It is difficult to estimate the amount of glaucophane in the rock, but it is rather less abundant than the hornblende and the garnet, and forms perhaps about one-sixth of the whole mass. From the fact that the glaucophane has not seldom a regular crystalline outline, as may be seen from the figures, and in other cases occupies cracks which traverse the garnet, I am of opinion that it is later in date than either that mineral or the normal hornblende, and probably than the compression which the rock has evidently undergone.

(4.) *Epidote*, rather irregularly distributed in small grains, often rectilinear in outline. This mineral calls for no special remark.

(5.) *Mica*. This mineral is not abundant, and is rather irregularly distributed in the slides; with transmitted light it has a slight tinge of green; I consider it to be one of the hydrous micas, and if not exactly a secondary product at any rate in an altered condition. Small colourless belonites are sometimes included in it.

(6.) *Impure Sphene (?)*. This mineral occurs in granules, occasionally assuming an outline which suggests a monoclinic crystal. Their diameter does not generally exceed ·005 inch. They occur in rather streaky elongated clusters, which seem to cut through the other constituents of the rock, and have been formed, I think, at any rate in part, in minute cracks developed by subsequent pressure. This mineral varies from moderately translucent to opaque, being in the former case a resin-brown. I cannot precisely identify it by microscopic examination alone, and it would be no easy task to isolate a sufficient quantity for chemical analysis, so I must leave this constituent undetermined, merely stating that I conjecture it to be a titaniferous mineral, and to contain iron. I have occasionally met with it before, and think I have seen it named zircon in some purchased

Digitized by Google

slides, but doubt this identification. Rutile is said to occur in glaucophane-rock from the Val Tournanche.

In one of the specimens, the glaucophane, and I think some of the hornblende, is bordered by a dull green microlithic mineral which appears to be nearly related to chlorite; this I have no hesitation in considering a decomposition product, so that I deem a further description needless for my present purpose.

Petrological Relations. This glaucophane-eclogite is associated with a set of schists generally rather fine-grained; these by the Swiss geologists are referred to the great series of bedded schists which form the highest group in the truly metamorphic rocks of the Alps. They are, in the main, the "*Schistes lustrées*" of some authors; the *grauekalkhaltiger schiefer* and *grüner schiefer* of the Swiss Geological Survey map, with which schistose serpentines are not seldom associated. The commonest rocks of the group are quartz-mica schists, often calcareous, and sometimes passing into beds of crystalline limestone or dolomite, but in certain districts, as on the southern slopes of the Pennine and in the Graian Alps, green schists are important members of the group, occurring, I think, rather in the lower part. Some of the green rock I believe to be only serpentines* crushed and rendered schistose by subsequent pressure, but others are chloritic and hornblendic schists, apparently of sedimentary origin. The series in this part of the Dora Baltea valley has a general south-west to north-east strike and a variable dip (not generally high) on the northern side; much evidence, however, of subsequent disturbance is afforded by corrugations and slickensided fractures. Below the glaucophane-eclogite† we have a calc-mica schist with some quartz, apparently interbedded with a green hornblende-epidote schist; above it a very fissile green schist, probably similar to that below in mineral composition, followed by a rock which is very possibly a crushed serpentine, and then a green schist, consisting chiefly of green hornblende and colourless mica with a little quartz and a few garnets. The eclogite varies a little in the coarseness of its constituents. It exhibits, as I have said, a slight foliation, and appeared to be interbedded with the schists above and below; but the former character is of little value in a region such as the Alps, and the evidence was not sufficient to determine the latter point. The rocks, on the day of my visit, were almost "whitewashed" with a thick coating of dust, and the time at my disposal did not allow me to endeavour to trace the eclogite up or down the craggy

* The word is used in its strict sense.

† Unfortunately I omitted to record the thickness of the exposure, but it is certainly several feet at least.

Digitized by Google

hillside, for this might have occupied some hours, and I could do no more without altering the plan of my journey.*

Comparison with other Specimens of Glaucophane.—I discovered a glaucophane rock on the sea shore at Pegli, a little west of Genoa, in the year 1878, and gave some account of it the following year.† As, however, it was rather cursorily noticed, for the paper was mainly on serpentines and the rocks associated with them, I will venture to give a rather fuller description.‡ The rock microscopically is a dull green "greenstone," rather minutely crystalline, with a rough fracture, tough, heavy, and evidently rich in a hornblendic constituent. It appears in the field to become in parts more coarsely crystalline, when it resembles "some of the gabbros on the Cornish coast, except that the pyroxenic constituent is less metallic and the 'saussurite' less abundant" (unfortunately I did not bring away a specimen of this variety of the rock). Microscopic examination shows that secondary mineral changes have taken place to a great extent. The felspathic constituent has been almost wholly obliterated, being replaced by a minutely granular, dusky looking mineral, associated with flakes of actinolite. A clear mineral in larger grains occurs occasionally, which may in some cases be felspar, but perhaps is more likely to be some hydrous silicate, or possibly now and then secondary quartz. The pyroxenic constituent has been converted into hornblendic minerals, as is commonly the case in gabbros; but here and there the close cleavage of the original diallage can still be discerned, and where this is most marked the mineral is dusty-looking, almost opaque, without definite characters. This is often bordered or traversed irregularly by glaucophane, and occasionally by ordinary pale-green actinolite. The glaucophane is abundant, and it appears to be a secondary constituent of the rock; most of it is more or less fibrous or "actinolitic" in structure, as is usual in the gabbros where the hornblende has resulted from the alteration of an original pyroxenic constituent—but (as may also be seen in such rocks)

* I hope the next visitor will endeavour to work this out. As it may prove, if it can be done, a rather long task, he had better sleep at St. Vincent, where the hotels are much better than at Verrex: if the roads are dusty he had better take a brush with him. He cannot miss the locality, it is on his left hand as he descends the high road.

† *Geol. Mag.* Dec. II. Vol. VI. p. 363.

‡ Mr. G. H. Williams (N. J. 1882, Bd. II. p. 201) notices a rock which he believes to be from this locality (of this I am doubtful), and intimates that I should have called it an *amphibolite*. As in 1879 it was not even certain that amphibolite denoted an igneous rock (I am not aware that there is harmony in its use now), and as I was satisfied the rock was of igneous origin, and had once been a gabbro, I preferred to call it (as I shall continue to do) a glaucophane-gabbro.

Digitized by Google

we occasionally find a grain (having usually its external outline rather ill-defined) where the characteristic cleavage of hornblende is very well marked; colour with transmitted light shades of violet blue inclining to ultramarine, with polarised light as described above, but perhaps a little less vivid. The slide contains a few granules of an iron oxide, but parts of some of the diallage crystals are replaced by an almost opaque mineral resembling a decomposed ilmenite. Glaucophane also occurs in a singular fragmental rock in the same neighbourhood, as to the origin of which I have not been able to come to any satisfactory conclusion.

Glaucophane seems to occur rather frequently in the central part of the Pennine Alps, for it is recorded as discovered at another locality, Champ de Praz, in the Val d'Aoste, also at Brozzo (near Ivrea) and in the Val Locarno (Stelzner, *Neu. Jahr.* 1883, Bd. I. p. 211). Strüver gives an analysis of the mineral from Brozzo, to which he gives the name *Gastaldite* (which, however, is now replaced by the older name glaucophane) (*N. J.* 1876, p. 664).* Glaucophane has also been found in the Val Tournanche near the Matterhorn (Cossa and Strüver, *N. J.* 1880, Bd. I. p. 162), and in pebbles at Germagnano (Williams, *N. J.* 1882, Bd. II. p. 201). On the north side of the Alps it is recorded from near Zermatt (Bodewig, *Pogg. Ann.* CLVIII. 1876, p. 224), and as an erratic in Switzerland (Stelzner, *N. J.* 1883, Bd. I. p. 208). Besides the original locality, the Island of Syra (Lüdecke *Zeitsch. deutsch. geol. Ges.* XXVIII. p. 248), it has been found by Dr. C. Barrois at the Isle de Groix (Morbihan), Brittany (*Ann. Soc. Geol. Nord.* XI. p. 45).

The composition is exceptional, the amount of Al_2O_3 being extraordinarily large, as will be seen from the analysis subjoined (Strüver). (The highest percentage in a list of 52 analyses of hornblende, given by Dana in his *System of Mineralogy* (pp. 238, 239), is 17·59; the specimen came from Bilin in Bohemia.)

SiO_2	=	58·55
Al_2O_3	=	21·40
FeO	=	9·04
MgO	=	3·92
CaO	=	2·03
Na_2O	=	4·77
K_2O	=	trace.
		99·71

* See also *Atti R. Accad. Lincei*, Ser. 2, Vol. II. p. 333. Here it is said that the specimens from the Val d' Aoste "furono estratti dagli affioramenti dei depositi cupriferi di Champ de Praz e S. Marcello." I cannot find on my maps the former place, but, as the latter is between Chatillon and Aosta, conclude the above localities are different from that which I have described. In this memoir the optical properties are described.

Digitized by Google

The glaucophane rock from Syra, in the British Museum Collection,* is a fine-grained light-grey to brownish schist (not markedly fissile) with conspicuous crystals of glaucophane, roughly about ·1″ × ·8″. Under the microscope the ground-mass mainly consists of a white mica interbanded with small granular quartz—much resembling, in fact, one of the quartz schists which occur in the Alpine series rather low down in the upper group of schists, *i.e.* probably not very far away from the horizon of the glaucophane rock described in this paper; the external angles of the glaucophane crystals are generally well-defined, though sometimes imperfect. They do not, however, seem to have been subjected to pressure, though the ground-mass does. The crystals are dark in colour, and the characteristic violet hue is not always perceptible. Glaucophane occurs in another schistose rock from the same island, in which is much of a mineral resembling impure epidote. The specimen figured by MM. Fouqué and Lévy (*Roches Eruptives*, Plate I. Fig. 2) is less markedly foliated than the British Museum specimen. In the Isle de Groix† the glaucophane occurs in no great abundance with greenish mica, epidote, garnet, hornblende and but little quartz. The rock has all the characters of a schist. The glaucophane crystals are of no great size, but fairly abundant in a specimen from Canton Valais (exact locality uncertain), with quartz, actinolite (?), and are often scattered about in patches of a chloritic mineral. The largest and most characteristic glaucophane crystals are in a rock from the neighbourhood of Zermatt; here their structure suggests to me the possibility of the replacement of a diallage. Comparing my own specimens with the above, I may say that the glaucophane in them is as characteristic as in any, and the crystals are only surpassed in size by those from Syra and Zermatt. I may add that in the majority of the above specimens the glaucophane appears to me to be more probably a mineral formed late rather than early in the rock's history.

---

* I am indebted to the President and Mr. T. Davies for the opportunity of studying the slides, &c. mentioned in this paragraph.

† I have a specimen of this and of the Syra rock in my own collection, for which I am indebted to Prof. Judd.

Digitized by Google

DESCRIPTION OF PLATE I.

Fig. 1.—Section of glaucophane-eclogite, exhibiting (1) glaucophane; (2) garnet, in a ground-mass chiefly composed of green hornblende (3); traversed by an irregular line (4) of the brown mineral (? impure sphene). In this section the principal crystal of glaucophane is cut parallel with the vertical axis.

Fig. 2.—Section of glaucophane-eclogite, exhibiting the same minerals, numbered 1, 2, 3, as before. The principal crystal of glaucophane is cut transversely to the vertical axis, and exhibits the characteristic outline and cleavage of a hornblende crystal. The sections are drawn with ordinary transmitted light, and the dichroism of the mineral is well indicated by the difference between the blue tint of the upper and the purple tint of the lower crystal. In each case, it may be noted, grains of the green hornblende are included in the glaucophane.

Magnified 27 diameters.

I have to thank Mr. Felix Oswald for kindly making the drawing.

T. G. B.

Digitized by Google

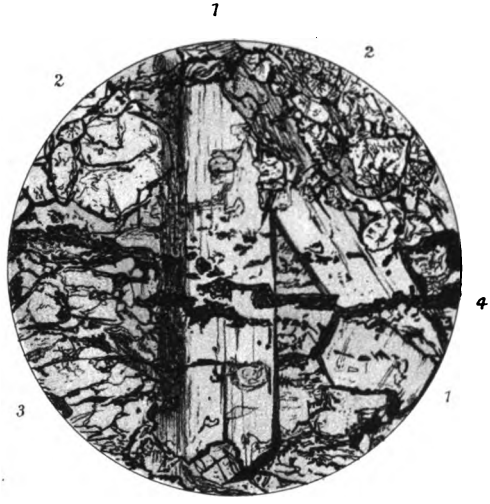


Fig. 1.

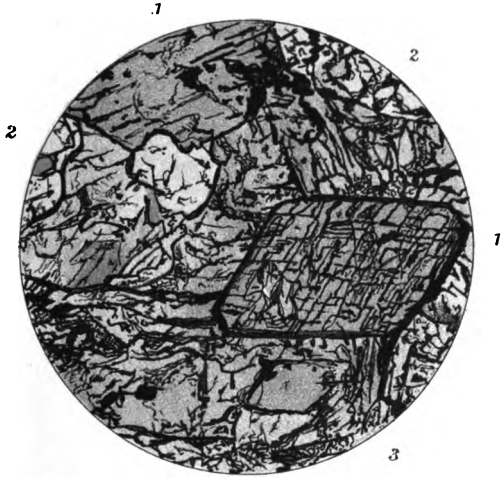


Fig. 2.

Mintern Bros. c

Glaucophane-eclogite from the Val d'Aoste.

Digitized by Google

Digitized by Google

On Idocrase and other Minerals recently found near Zermatt.

By W. J. Lewis, Professor of Mineralogy in the University of Cambridge.

[Read December 8th, 1885.]

SOME Zermatt Guides (Joseph Taugwalder and his brother) made, on a recent excursion up one of the mountains (Pollux ?) in the neighbourhood, the discovery of some very interesting crystals of idocrase and red garnet.

The idocrase crystals are of a dark sherry colour, and are developed in simple forms, the prism-planes $m\{110\}$, $a\{100\}$, and the base $c\{001\}$, being well developed. The edges [cm] are truncated by narrow planes $u\{111\}$, and at the corners small planes $i\{812\}$ are sometimes found. The prism planes are deeply striated, and at the same time the c plane shows more or less coarse squares, which sometimes seem to belong to independent crystals. The sides of the square are parallel to the $a\{100\}$ faces. The crystals have, therefore, much the character of a bundle of thin pyramidal crystals united together in parallel positions.

Both faces c are generally present, but one of them is bright, whilst the other has commonly an incrustation on it or seems to have been corroded. The larger crystals are as much as 30 mm. long by 28 mm. across. One fine specimen is about 30 mm. high, 28 mm. along one normal to m, and only 13 mm. in the direction perpendicular to these. In this latter crystal both c planes are bright, and the square markings are unequally developed on different portions of the same face.

The crystals sometimes show at one extremity a curious change similar to that common in beryls from the Mourne mountains, and which seems to be a result of corrosion.

The almandine crystals associated with the former mineral are of a bright deep red, they consist of the rhombic dodecahedron $\{110\}$ together with the forms $\{211\}$ $\{321\}$. The faces $\{211\}$ are largely developed and much striated, and the faces $\{110\}$ are often reduced to narrow lines.

Digitized by Google

Orthoclase from Kilima-njaro, and Adularia from Switzerland.

By H. A. Miers, M.A.

[Read December 8th, 1885.]

Orthoclase from Kilima-njaro.

PROFESSOR BONNEY has described, in the British Association Report for 1885, the rock specimens brought from Kilima-njaro by Mr. H. Johnston, and has called attention to the peculiar form of the felspar crystals which are porphyritically developed in a rock referred by him to augite-andesite. It is at his suggestion that a more detailed account of these crystals is here attempted.

They are of a brown to yellowish-brown colour, full of cavities, and considerably weathered, and are so much rounded that it is impossible to determine their nature with certainty by means of the hand goniometer. They sometimes attain a length of 35 mm.

Two distinct habits of the crystals are shown in figures 1 and 2. In the former the angle *mm* was roughly measured as lying between 53° and 57° (in one case 61°), while the inclination of *y* to the edge *mm* is about

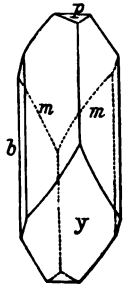


Fig. 1.

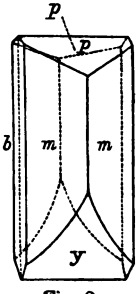


Fig. 2.

35°. *p* is generally found only as a cleavage face, and there is also a ready cleavage parallel to *b*. The form shown in fig. 2 is evidently a twin growth, for the cleavage surface is here repeated at the back of the crystal, which is now symmetrical about a plane truncating the edge *mm*. In this case the angle between the two cleavage faces *pp'* can be measured with some accuracy by the reflecting goniometer, and is found to be 52°20′.

Digitized by Google

If then the crystals are orthoclase they appear to be a combination of the forms $m = \infty P \{110\}$, $y = +2\breve{P}\infty \{20\bar{1}\}$, $b = \infty \breve{P} \infty \{010\}$, and sometimes $p = oP \{001\}$, twinned on the orthopinakoid (100), that is to say according to the Carlsbad law, but distinguished by this peculiarity—that the individuals are united, not by irregular penetration or along the clinopinakoid, but along the orthopinakoid; in other words the plane of twinning is also the plane of junction.

To make sure that this is so sections were cut across one of the twin crystals in two directions, parallel to the cleavage planes p and b.

In the basal section the twin junction is seen to run across the crystal in an uneven line perpendicular to b, while the directions of extinction in the two halves are nearly the same, namely, parallel and perpendicular to b. The other section shows the two individuals clearly defined; the directions of extinction in each are nearly parallel and perpendicular to p (inclined at 5° to p), and are therefore inclined to one another at angles of 42°20′ in the two halves of the section. The usual appearance of the twin crystals is shown in fig. 3, one individual thinning off rapidly towards the prism edge.

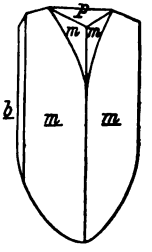


FIG. 3.

Finally, a section cut perpendicular to the cleavage p and examined in the polariscope, shows both optic axes symmetrically disposed about a plane parallel to b, their apparent angle in air being nearly 102° (sodium light).

In other words, the plane of the optic axes nearly coincides with the basal plane p, $2E = 102°$, and the first mean line is parallel to the plane of symmetry b.

There remains no doubt, therefore, that the crystals are orthoclase of most unusual habit, twinned according to the Carlsbad law, but united in such a way that the plane of twinning is also the face of composition.

It may be added that the sections show the crystals to be full of enclosures; but especially characteristic are small parallelepipedal spots of which the sides are parallel to the faces $p\ b\ y$. These may be cavities filled with decomposition products. Parts of the crystals viewed by polarised light exhibit a well-defined cross-hatching parallel to the pinakoid faces.

It has been pointed out to me by Mr. Teall that this orthoclase is similar to the felspar of the "rhomben-porphyr" from Christiania. The resemblance is very close, both as regards the habit and the mode of twinning (see *Mügge. Neues Jahrb. 1881* (II.), p. 107).

Digitized by Google

Adularia from Switzerland.

A crystal of adularia picked out from among some Swiss minerals by

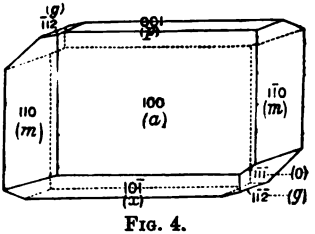


FIG. 4.

Mr. Davies because of its remarkable habit, is worthy of description. The form of the crystal is shown in fig. 4.

It is tabular owing to the large development of the orthopinakoid faces $a = \infty\breve{P}\infty$ {100}. The forms $m = \infty P$ {110}, $p = oP$ {001}, and $x = +\breve{P}\infty$ {$\bar{1}$01} are symmetrically developed, but $o = +P$ {$\bar{1}$11} and $g = +\frac{1}{2}P$ {$\bar{1}$12} appear only on two opposite corners, giving the crystal a very asymmetrical aspect.

Both *a* and *g* are rare faces. *a* occurs on orthoclase from Striegau, Hirschberg, Elba, and Schiltach, and on adularia from Pfitschthal and Zillerthal. As a large face giving a tabular habit it has been described by F. Klocke (*Berichte der naturforschenden Gesellschaft zu Freiburg*, 1876, vi. Heft 4, p. 17), on orthoclase from Schiltach in the Black Forest. *g* was described by Weiss as interesting because apparently inconsistent with the symmetry of the system, since with his parameters it would have a horizontal edge with *b*, and would be equally inclined to the *m* faces. (In reality *gm* is 89°8′ on one side and 81°12′ on the other.) The face was established for the first time by Hessenberg in 1863 (*Min. Not.* v. p. 12) on adularia from St. Gothard.

On the crystal fig. 4 all the faces are fairly smooth and bright with the exception of *a*, which is unevenly striated parallel to its intersections with *m* and *p*, and is rounded towards the *m* faces.

Digitized by Google

On the Nomenclature of the Hydrocarbon Compounds, with a suggestion for a new classification.

By Andrew Taylor, F.C.S.

[Read May 21st, 1886.]

SINCE many of the minerals grouped as hydrocarbon compounds in Dana's Mineralogy have become extensively *exploited* for their commercial uses, allied questions in chemical geology and in their classification have bulked largely in scientific discussion. Thus their place as rocks or minerals in petrology has been mooted; for it is difficult to make out definite chemical composition or crystallographic form in many of the materials of the group now used for heating, lighting or paving. Notably the question, What is coal? has not been authoritatively removed from the range of scientific controversy—though the supply of the mineral which occasioned the great trial Gillespie *v.* Russel, nearly thirty years ago, was, until last year, considered exhausted. Diligently bored for to its exact position in the Scottish carboniferous series of rocks, no trace of it has been found except in its limited basin of four miles area or so around Torbanehill, Linlithgowshire. The centre of the basin, where the mineral was found, about two feet thick, has been thoroughly worked out for nearly fourteen years. But mining operations on the eastern and western extremities of the basin, both of which are much riddled by cross faults, have last year been rewarded by the finding of a few hundred tons, which have been sold on the Continent for gas enriching. So far, then, "Torbanite" and "Bathvillite" need not be regarded as extinct. But this nomenclature has not in the interval displaced the common use of "Boghead gas coal" or "Torbanehill Mineral" in popular use. Hence another plea against topographical names as applied to mineral species. The progress of the Scottish shale oil industry, which originated after the expiration of Young's Patent in 1863, when this mineral was considered exhausted, has thrown some side lights on its formation. During the "What is coal?" discussions of 1853 and the following years, it was clearly shown that the problem could only be fully solved by the study of individual mineral species of the class. Now oil shale, which at this period was hardly known either in commerce or mineralogy, presents at least many analogies to the Torbanehill material which formed the basis of Young's manufacture of

Digitized by Google

paraffin and mineral oils. The substances approach each other in streak, sectility, texture and fracture. They are alike clayey beds, yielding crude oil in varying degrees; for while Torbanite gave commercially one hundred gallons per ton, a substance is reckoned a workable oil shale if it yields thirty gallons per ton. The shale-refuse left by the new retorts, which utilise all the carbonaceous matter either as oil or subsequently as fuel, is a clay showing a large proportion of iron in its composition. The peculiarly white silicate of alumina left by Torbanite, the "ghaist" from which no old woman could obtain domestic services at her fire, was held at the trial to be its grand characteristic—distinguishing it from the coke-yielding cannel coals. Now, so far as the argument from geological position is concerned, Torbanite stands just above the upper limestone supposed to indicate the basis of the coal-measures, while the workable shales appear as yet confined to the lower carboniferous series. But these shales appear also bounded by a limited area, of which the Bathgate Hills form one extremity and the hills above Burntisland another. In the East of Fife, for instance, a totally different order appears to characterise the same geological horizon; for here "rum coals," or shales having all the other mineralogical characteristics of bituminous coal, appear.

The limited geognostic conditions prevailing in the first area generally from Edinburgh to the Bathgate Hills, appear to have been specially favourable to the appearance of a basin containing a seam of Torbanite, as well as of several others containing six workable shale seams. In faults, and other rock crevices, as well as intimately connected with the unique trap ridges, ozokerite, elaterite and other petroleum compounds have been found. Indeed "salse" action appears a probable explanation of some special petrological peculiarities both in the traps and their surrounding metamorphosed limestones and sandstones. And as petroleum flows are regular concomitants in the action of mud volcanoes, it is no improbable conjecture that beds of clay may have been saturated with oleaginous matter just as they were formed. Plant remains are abundant in the shales, as well as in the Torbane hill mineral. But the Broxburn oil shales are now also marked as the geological horizon for rare species of fossil fishes, and the old hypothesis that useful oleaginous matters in coal and shale were derived from vegetable eremacausis appears thus to break down. For were not the foul smells of some crude oils derived from such shales as the Kimmeridge beds regarded as proofs of their animal origin? According to the late Alfred Swaine Taylor a bituminous shale is a clayey substance with coaly, bituminous matter in it. A bituminous coal had an overplus of the oily principle, with little ash when burned,

Digitized by Google

and no clayey smell or appearance about it. "The greater or lesser quantity of clay makes the shale; and the greater or lesser quantity of bitumen, with a deficiency of clay or ash, makes the coal." Such was the gist of evidence given at the great trial, Binney and Company against the Clydesdale Chemical Company, in 1860. And, indeed, Professor Traill moved on similar lines when he designated the Torbanehill mineral, "Bitumenite," in 1853.* But manufacturing chemistry has demonstrated that these oil shales contain no bitumen, which belongs, along with petroleum, to the methyl series of hydrocarbons; and that their products belong to the ethyl or paraffin series, as also does ozokerite. At the great pitch Lake of Trinidad maltha hardens into asphalt or bitumen, while in another part of the lake the ozokerite compounds are simultaneously forming. Near at hand, too, lignite is being formed in proximity to an active mud volcano: all this apparently an extended protest against the opinion that coal can only be the product of decaying vegetation, or that a body in any respect approaching cannel coal can only have been formed through macerated leaves floating in shallow lakes. Bituminous shale became of legal importance when Du Buisson filed his English patent for distilling it, as he had previously successfully obtained paraffin oils from like material at Autun, in France. But the attempt to work this, in 1853, from the Kimmeridge shale was unsuccessful; so much so that attempts to utilise the Scottish oil shales shared much obloquy, because of anticipated foul smelling products like those from the Wareham deposit. Even now, the term "shale" is employed in law courts in such fashion as to show how a popular, easy-going, semi-scientific phrase may only darken knowledge—schist, slate and shale are defined in older books on rock-classification, such as that of Macculloch, as signifying a fissile structure characteristic of rock masses of most varied mineral constitution. The first two terms specially designated this in rocks of the so-called primary formations, while the term shale was confined to rocks having this structure, which can be seen alike in hæmatite and bituminous coal, and in rocks in the higher geological horizons. Torbanehill mineral was generally dug in cubical blocks; and last year isolated cubes mixed with unhardened clay were mostly dug out; but what is being presently mined shows a slaty structure. The term oil shale, recently introduced, appears too indefinite. Thus Professor Liversidge protests against the term "kerosene shale" being applied to the Torbanite of Hartley, New South Wales, now exported to Europe as a gas enricher.†

* *Trans. Roy. Soc. Edin.* Vol. 21.

† *Journ. Roy. Soc. New South Wales*, Vol. 14, p. 206.

Digitized by Google

It has not the characteristic lamellar or slaty structure of a shale; for even *in situ* the planes of stratification, quite invisible in hand specimens, are mainly apparent by the presence of layers or films of earthy matter. Like typical Torbanite, it gives a dull wooden sound when struck; the powder is light brown to grey, and the streak shining. It usually weathers to a light grey colour, the surfaces of the joints being often coated with a white film. Its broad conchoidal fracture, with concavities sometimes very deep in proportion to their breadth; its easy sectile characters, as well as its peculiar microscopic appearances, and its ash, sometimes practically white, all resemble the Torbanehill mineral. Many of its specimens show, when analysed, only half the fixed carbon of the latter, while it practically yields more gas and oil when distilled. Tourba from Brazil approaches Torbanite in many characters. It yields one hundred gallons crude oil per ton, burns readily in a candle, leaving the same matter as before, while the pure white residue of silicate of alumina is like that of Torbanite. Its greyish or brownish colour and felty texture reminds one of the streak shown by the knife on Torbanite or the "curley oil shale." According to Hartt, the section at Camamui Bay, Province of Bahia, Brazil, exhibits a variation from pure bitumen to arenaceous material interstratified with oil shales, suggesting the infiltration of oleaginous matter into sands or clays. In truth the three minerals just enumerated have similar properties, and are essentially one, though confused by inappropriate nomenclature. Professor Silliman proposed the name of *Wollongongite* for the New South Wales mineral; but this would only perpetuate a misleading topographical classification. The mineral at present shown as Boghead Coal in the Edinburgh International Exhibition, 1886, has a very yellow streak, indeed appears like consolidated Tourba; it is certainly not a coal. It is from the Alps above Vienna.

The grouping of the old class of the combustible minerals under the series of hydrocarbon compounds certainly indicates their usual geognostic relations. Thus Ozokerite, of the consistence of butter along with liquid oil, was found in a bore for shale at Broxburn in 1885, though not so abundantly as to inaugurate the mining of this Hungarian candle-stuff material in Scotland. Further, Mr. Galletly has described a bedded mineral, possessing all the external characters of Albertite, found interbedded in an oil shale seam at Addiewell, West Calder.* It yielded 88·75 gallons crude oil per ton, and its matrix only gave about 40 gallons. Like the Albertite of Canada and Ross-shire, as well as the surrounding

* *Trans. Edin. Geol. Soc.* Vol. II. p. 395.

Digitized by Google

shale, the large excess of hydrogen to carbon in its composition was similar to that in Torbanite. It approximated also in specific gravity to the last-named mineral. Now might not this family relationship be pictorially presented to the eye by graphic symbols? The result of retaining two or three old nomenclatures to describe minerals of such constant use, and with so many new relationships, is disastrous to specific designation; and consequently, a critical investigation of many of the individual species may lead to a new grouping, which might even alter the position of some presently recognised cannels and lignite. After all, symbols, even without the old names, might be employed to designate the present well-known compounds of the series. Whilst clearly demarcating the true bituminous and paraffin groups, a connection with the series of oxygen and the true hydrocarbons would have to be shown, as this undoubtedly occurs in nature. Thus a shale deposit at Blueskin, near Dunedin, New Zealand, shows such crystallised compounds of oxalates as Humboldtine and Whewellite imbedded in the main deposit, which yields about 50 gallons crude oil per ton. As the section is capped by basalt, it suggests a heat of 400° F., which is found necessary for the manufacture of wood shavings into oxalic acid; and as similar associations of oxalates and brown coal or shale are known in Bohemia and Canada, such facts demand recognition in any scheme of natural classification. The natural relations betwixt bituminous coal, anthracite, graphite and the diamond would also have to be grouped. As discovery has progressed, it is certain that mere geological position has not influenced the genesis of the mineral series under discussion. Geognostic position, which may be duplicated from many geographic centres, appears to be the main requisite in the genesis of these minerals. The carboniferous system now only indicates where coal beds occur most abundantly; and oil wells and paraffin yielding deposits, or minerals like Torbanite, are now found in every geological formation.

Digitized by Google

The Metallic Ores of Chili.

By John F. Kerr, F.G.S.E.

(Communicated by Professor Ivison Macadam.)

[Read May 21st, 1886.]

THE ores which I have the honour to submit for your inspection were collected by me in Chili. They consist of numerous compounds of copper, silver, gold, &c., and represent the very varied minerals obtained in that country.

Besides the primary metal there is usually at least one secondary body of value present.

The proportion in which this secondary metal—I mean secondary as regards quantity—is present in metallic ores does not seem to be a mere chance affair, but seems to follow some law. My attention was directed to this matter by the silver ores from the district of "Lomas Bayas" near Copiapó. These ores contain gold in a certain proportion, not in relation to the gross weight of the ore but to the contents in silver. As you will see by Table I. the proportion is nearly 1 of gold to 100 of silver, and so near

Table I.

Assays of Ores of Silver and Gold.

Silver.	Gold.
.00385	·0000385
·003930	·0000400
·014715	·0001550
·015536	·0001640
·004516	·0000440
·005150	·0000500
·003566	·0000335
·002880	·0000308
·004320	·0000400
·004760	·0000500
·005040	·0000550
·003040	·0000250
·007900	·0000700
·008060	·0000700

does this proportion hold good that if the results of assay vary much from it the assay is distrusted, and often has to be repeated.

Digitized by Google

Table II. shows assays of copper and silver ores. In some of these

Cu is to Ag : : 1000 : 1
Some ,, ,, ,, : : 100 : 1
Some ,, ,, ,, : : 200 : 1

and other various proportions.

TABLE II.

Assays of Ores of Copper and Silver.

Copper.	Silver.
·422	·00042
·262	·00026
·285	·00033
·338	·00040
·198	·00180
·145	·00134
·109	·00115
·168	·00195
·591	·00030
·358	·00196

Table III. shows the proportions of silver to lead yielded by galenas

TABLE III.

Galenas.

	Lead.		Silver.
Finisterre	1	:	0·000923
Lozere	1	:	0·003929
Savoy	1	:	0·002745

from different parts; the decimals representing the proportions of silver to 1 of lead, being almost multiples of the lowest, as 1 : 3 : 4, and the decimal on Table IV. gives another multiple 15, so that we have silver to lead as 1 : 3 : 4 : 15 in these examples.

These relationships between the figures clearly point, I think, to some law regulating the proportions of different metals found in company in nature.

If we now turn to the composition of minerals, we shall find indications that this law has some reference to the combining weights of the metals.

Line 2 of Table IV., taken from Dana's Mineralogy, shows the average composition of Bournonite in ten samples from different parts of the globe.

Digitized by Google

	Ag.	Sb.	As.
			·98
			2·90

[illegible] the figures [illegible] composition to [illegible] we get

[illegible] with which [illegible] and the [illegible] the examples. the

	S.	Sb.	Ag.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	S_3	Sb_2	Ag_2
	17·7	22·5	59·8

[illegible] antimony the sulphur is equally divided between the antimony and the other metals, one half being taken up by the antimony and half by the other metals present. In the pyrargyrite the second half of the sulphur is taken up by the only other metal present, viz. silver.

Digitized by Google

but in the Bournonite the other metals present, viz. lead and copper, lay equal claim to the second half of the sulphur and divide it exactly between them.

This would appear to indicate a tendency of some metals to claim a half or other large share of the non-metallic element in the mineral, and of other metals to share the other half or remainder as equally as possible among them.

We have examples of this in galenite, where lead is present in the largest proportion, and by taking up its proper share of sulphur to form PbS, will leave only a very small share of sulphur to divide up among the other metals, which have been able to get into the mineral by dividing this remainder among them; the zinc, however, claiming a preference, and putting in 3 equivalents, thus appropriating one half of the remaining sulphur, while the antimony, iron and copper are each represented by 1 equivalent.

In stannite, where copper supplies $4=\frac{1}{2}$ of the 8 metallic equivalents present, tin supplies $2=\frac{1}{2}$ of the remainder, and iron and zinc 1 equivalent each to complete the number. In this example the number of equivalent of the non-metal is the same as that of the metals. Another example is Barnhardtite, in which copper and iron are combined with sulphur in the ratios of 2 equivalents of copper to 1 equivalent of iron.

In chalcopyrite the same metals are combined with sulphur in the ratio of 1 of copper to 1 of iron. And in Cubanite the same metals are combined with sulphur in the ratio of 3 of copper to 7 of iron. In these few examples we see that the metals, in their joint combinations with non-metals, manifest preferences, but the preferences are not always on the same side, but, like good friends and good fellows, the metals mutually prefer one another even to the extent at times of taking equal shares; and they evidently do so by rule, whatever that rule may be.

Among the specimens on the table are a few rarities. One of these is a specimen of nitrate of soda, not the commercial substance, nor taken from the "salitreras," but taken from a much more elevated source, viz. from the Cordilleras at a height of about 14,000 feet above the sea. I have always understood that the source of Chili or Peruvian saltpetre is in the beds beneath the surface soil found in Peru and Chili. This is certainly the commercial source of nitrate of soda. But where do these beds get their supply from? The "salitreras" are found in flat, low-lying tracts of country, and are residues left by the evaporation of water whose journey towards the sea has been stopped at those places by the nature or formation of the ground; but where does the water get the

Digitized by Google

nitrate from? Some rocks contain soda which is gradually dissolved out as the rocks are decomposed by the weather, and carried away by rain and snow waters; and I have heard that it is converted into nitrate by the action of the nitrogen of the atmosphere. But this process is slow, and somewhat evenly spread over the face of the earth, and, I think, can scarcely account for the immense accumulations of nitrate in certain parts. Some may be formed in this way, but I think the water which supplies those "salitreras" must encounter the nitrate in some more handy form, and the sample before you shows what that form is. The genuineness of this sample I can vouch for, for I was present and saw it taken from its vein and have kept it carefully ever since.

At the height stated, about lat. 24° S, at the edge of a valley where the rocks are broken off abruptly, a "cateador" saw veins of some sort and a white crystalline substance in some of them, and, as it is these men's business and habit to pick up and examine everything they come across to find out whether it is of value or not, he picked off some, and, among other tests, he put a sprinkling on his lighted cigarette, when the increased combustion of the paper and tobacco at once told him what he had found. Well, in the rocks at this place there are a great many veins of this nitrate, between hard rock on either side; the length of the crystals in the bottle—about 1½ inches—shows the thickness of some of the veins from which they were taken, the crystals run transversely and have somewhat the appearance of lump sal-ammoniac. These veins were found cropping out here and there over a large area, and the thin soil in many places contained a large amount of nitrate. This specimen of nitrate is very pure, giving no indications of either sulphates or chlorides, and yielding to analysis 99·1 per cent. nitrate of soda.

Here, I think, we have the primary source—so far as it is possible for us to trace—of the great deposits of "salitre," in the "salitreras" of Chili and Peru. I don't think this source will ever become a commercial one, from the inaccessibility of its position. The cost of transit of supplies and of the nitrate, and the cost and difficulty of labour at that elevation, would be too great. It might pay if it had simply to be dug up as at the lower levels, but it would have to be mined and the veins followed in hard rock, so that for commercial purposes the source of supply will still be the "salitreras" of the plains. But to mineralogy the primary source must be the nitrate pure and crystalline existing in veins in the rocks at the higher and the highest elevations of the Andes.

Beds of salt are also found in the same locality referred to, and salt lakes at that great height supply huge blocks of salt for domestic and amalgamating purposes.

Digitized by Google

Another specimen is of vitreous native sulphur, broken off the outcrop of a vein of that substance 6 feet thick, which is seen to run for miles along the hillside at the same elevation.

There are also a few flat pieces of stone with which the mountain sides are covered as a thin layer over a great part of the same region. They will let you see the kind of rock existing there.

Another specimen is of sulphate of lime in needles, from a surface deposit in the desert of Atacama.

One specimen of silver ore contains ruby silver—pyrargyrite. Some contain native silver, and others are of different composition.

Digitized by Google

New Localities for the Mineral Agalmatolite, with Notes on its Composition.

By William Hamilton Bell, F.G.S.E.

[Read May 21st, 1886.]

THE rock-like mineral, known as Agalmatolite, derives its name from the Greek word αγαλμα, an image. It has also received the trivial name of Pagodite from Pagoda; it having been long used by the Chinese as the substance from which they carve their images and pagodas.

The earlier mineralogists confined the above names to hydrated silicates of alumina and potash, doubtless a product of the decomposition, or alteration, of orthoclase felspar; an intermediate stage in its conversion into the kaolin which is so abundant in the Celestial Empire.

Jameson, Phillips, Allan, Nicol, and all the fathers of mineralogy, admitted no other substance under the name. Nicol, who was a thoroughly well-read mineralogist, writes: "Many substances are named Agalmatolite which are really distinct;" and he clearly defines the species, which he makes the same as that called Agalmatolite in the present communication.

As the number of mineral analyses increased, we find magnesian silicates to have been placed in the same category, so that in the ponderous work of Dana the term has been more or less loosely applied to the following three different substances:—

First. The substance already noticed, the true Agalmatolite, which is a massive variety of Pinite.

Second.—A massive, and what has been called an indurated, variety of steatite. This is a hydrated silicate of magnesia.

Third.—A massive pyrophyllite, which is a hydrated silicate of alumina; differing from true agalmatolite in containing no silicate of potash or other alkali.

Professor Heddle, in his article on mineralogy in the *Encyclopædia Britannica*, again restricts the name Agalmatolite to the substance which originally was so designed; and it is well that it should be so restricted, as there is evidently much want of precision in the including of steatitic or magnesian minerals under the title.

There is a similar and a similarly misleading vagueness in the manner of using the term potstone, which in some of its properties resembles this.

The formula which Dr. Heddle gives for Agalmatolite, in his article in the

Digitized by Google

Encyclopædia Britannica, is $4Al_2O_3\,2SiO_2+2K_2O\,3\,SiO_2+2H_2O$; this gives in percentages 55 per cent. silica, 33 of alumina, 7·6 of potash and 5 of water.

The first discovery of Agalmatolite in Britain was by Dr. Heddle himself. In his *Geognosy of Scotland* he states that it occurs at several points in the bands of Laurentian gneiss in Sutherland, and especially at the end of the hill Kean-na-Binn, at Lua Yayi near Eriboll. In his *Geognosy of Scotland*, he gives his analysis of the mineral as found there :—

Silica	48·723
Alumina	31·58
Ferric Oxide	2·43
Magnesia	1·809
Potash	9·485
Soda	1·312
Water	5·752
	101·091

Hardness 2 to 3, cuts like slate pencil, specific gravity 2·8 to 2·9; and he makes the following remarks :—"It is many years ago since Dr. MacCulloch "threw out the suggestion that indurated steatite was of the nature "of Agalmatolite. Of several substances which might lay claim to such "a name as indurated steatite, this is perhaps that which most deserves it. "The above analysis shows the nature of the substance for the first time, "and probably proves Agalmatolite to be British. The definite informa- "tion thus obtained enables us to recognise as the same mineral certain "hitherto doubtful green masses which occur in the granitic rocks. "This substance, and its probable mode of formation, was also noticed by "Hay-Cunningham, who writes: 'Near the village of Rispond, the gneiss "makes a transition into a rock, composed of large concretions of serpen- "tine, between the two there being also every mode of gradation.' "Cunningham's serpentine is the Agalmatolite; while I have to admit that "it is a mere conjecture (indeed the merest conjecture, seeing that pieces of "oligoclase equally large are rarely to be seen in these felspar bands) "which assigns the occurrence of the mineral to a change of oligoclase, "yet I have to say that I have not infrequently seen orthoclase passing "in its exposed surfaces into a substance not to be distinguished from this. "I instance the orthoclase of a dyke at Geo-na-Shermaig, of an infiltration "vein at Knock Dhu near Lairg, and probably a similar vein in the red "granite near Murdoch Head Quarry, in Aberdeenshire."

In 1881 and 1882 I was engaged on an inquiry into the serpentine rocks at Coyle Hill, near Ballater, Aberdeenshire. During my inquiry

Digitized by Google

I became acquainted with the constituents and appearance of these rocks, and was struck on finding, in the granite rocks in Ballater Pass, a mineral so similar in appearance to serpentine, that, like Hay-Cunningham, I called it serpentine, or serpentinous matter in the granitic rocks.

Ballater Pass runs between the hill Craigendarroch (at the foot of which Ballater lies) and another hill about 500 feet high, a mile north-east of Ballater. Both hills rise abruptly on each side of the Pass. The rocks on the east are a mass of confused blocks of coarse red granite; and it was when searching minutely for minerals which I had been told were to be found there, that I came across Agalmatolite. I was puzzled at its frequent occurrence, although in small quantities; but as serpentine is found everywhere in that neighbourhood, I allowed it to pass from my mind, but kept the specimens. It was only during the spring of last year (1885) that the finding of this mineral recurred to me, by reading the quotation I have made from Dr. Heddle's *Geognosy*. I was further interested in it on reading the report of Messrs. Peach and Horne on the question raised by Dr. Archibald Geikie on the north-west succession of rocks at Eriboll, and where this substance Agalmatolite is introduced. This report is found in *Nature*, in November 1884.

It occurred to me then that the mineral which I had found in 1880 in Ballater Pass was Agalmatolite, and on my showing my specimens to Dr. Heddle, he at once identified it as that mineral last summer. As I had no particular leaning to geological inquiry elsewhere, I returned to Ballater to prosecute my researches in this and other matters previously noticed there. I found this mineral in several parts of the Pass, but generally interspersed throughout the granitic rocks, and I sometimes found it running along a joint of the rock, as if it had, in a pasty semifluid state, been seeking an entrance there. On breaking up the rock, however, I never found that it had obtained an entrance. I have seen the mineral in this way run along a straight line of joint for yards.

My first search was in two quarries about 200 feet up a "ruckle"* of loose granite blocks, and the above was all I found there; but on going up the Pass to the west, about 200 yards from the stables of Monaltrie House, and crossing the Ballater Burn by a wattle bridge, I found it in great quantities; the mineral was also found in greater thickness, but generally seemed to cover the blocks; indeed, about this spot there was hardly a block that was not permeated by it or covered with it. I found it mostly at this point and in the rocks at the bottom of the *débris*, which

* "Ruckle" or "rickle," *anglicé*, a rough heap.

Digitized by Google

extended 200 feet up. I saw, however, green or yellowish matter like it on the solid rocks, at the very top of the cliffs, which were quite inaccessible to me.

When I returned from Ballater Dr. Heddle kindly asked me to go to St. Andrew's with my specimens. The result of our comparison of my specimens with those in his possession was that he expressed himself satisfied with their identity, and that he has little doubt that they would be found to be identical in substance with the Sutherland mineral. He, however, pointed out that from the intimate intermixture in my specimens with the silica, especially of the granitic matrix, it would form an almost impossible task to separate it sufficiently therefrom for analysis.

We found in one of the Supplements to Dana's Mineralogy that the mineral occurs at Glyden Bech, in Carnarvonshire; and after full consideration, we came to the conclusion that it was identical with my specimens, although the locality is new. The mineral may not, however, be of very rare occurrence, as Dr. Heddle stated that he had found it in Rubeslaw Quarry. Mr. Henry Mowbray Cadell, of the Geological Survey, also found it at East Ruadh, in Glen Fynne. Mr. B. N. Peach, also of the Survey, obtained long slabs of it from under the sea at Peterhead when the Harbour Works were being carried out there; Mr. MacConochie, also of the Survey, found it on the east side of Loch Garve, in Ross-shire, at the foot of Little Ben Wyvis; and Mr. Livingston, Rector of Fort William Academy, has obtained it in Glen Loy, near Banavie, on the road to Loch Arkaig.

In all these localities. including that in which I found it, the mineral is looser in structure than that from Eriboll, analysed by Dr. Heddle. Mr. Peach has also given me a piece from the same place; it has a more scaly appearance. This, however, would arise from its containing a minute quantity of what is probably mica.

Professor Ivison Macadam has kindly analysed the mineral as I found it, and also Mr. Peach's specimen from Kean-na-Binn, near Eriboll. (p. 28.)

The large amount of silica here obtained, certainly, at first sight, seems to throw doubt upon this being Agalmatolite. Mr. Macadam writes to me: "Looking at the care with which the material was picked, and the fact "that no silica was observable even when the rough sample was viewed "under high microscopic powers and with the polariscope, I am inclined to "consider the whole of the silica constitutional, and look upon the slight "variations in the proportions of silica shown by the analyses of your "samples as bearing out this opinion. I am inclined to the belief that this "mineral is formed under similar conditions to Agalmatolite, excepting "that silica has been present in greater proportions than is necessary to "form true Agalmatolite."

Digitized by Google

Dr. Heddle thinks this is equivalent to making it a new mineral, and observes that "if we regard it as a mere mixture of true Agalmatolite and "silica, that intermixture would amount to about two-thirds of the "whole, and that so large an amount of silica cannot be in union with the "basis in any true mineral." Dana, who places Pinite among the uni-silicates, remarks:—"Agalmatolite is like ordinary massive Pinite, but "contains more silica, so as to afford the formula of a bi-silicate, or nearly "so, and it may be a distinct species;" and in the last edition of his "work he gives no section of ter-silicates, remarking, "The species "hitherto arranged under that head being proved to have no existence."

Dr. Heddle, remarking on the above, shows that, with the exception of combinations with lithia and glucina, 55 per cent. given for Agalmatolite is about as high as in the most acid silicates, and thinks that the question of admixture with free quartz could be settled by an examination of the picked material with the polariscope, the high depolarising powers of quartz would enable its presence to be at once detected.

Analyses by W. Ivison Macadam, F.I.C., F.C.S., &c.

		Ballater Pass.		
	Kean-na-Binn.	No. 1.	No. 2.	No. 3.
Silica...	51·219	84·295	83·225	84·744
Alumina	33·046	8·593	9·991	10·131
Ferric Oxide ...	2·522	1·481	2·448	0·841
Magnesic ,, ...	0·331	2·112	1·112	1·301
Calcic ,, ...	0·141	1·586	1·077	1·013
Potassic ,, ...	6·495	2·045	2·125	2·325
Sodic ,, ...	0·184	0·163	0·132	0·154
Water	6·027	—	—	—
	99·965	100·275	100·110	100·509

Digitized by Google

On a New Locality for Agalmatolite.

By W. Ivison Macadam, F.C.S., F.I.C., &c., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read 21st May, 1886.]

THE specimens to which this note refers were obtained from a precipitous cliff at the north-west end of Loch Maree, Ross-shire, called Creag Mhôr Thollie. The mineral occurs on the 1,000 ft. contour to the east or loch side of the Creag, and is in quantity. The analysis gave:—

Silica	63·256
Alumina	26·414
Ferric Oxide	1·832
Magnesic ,, ...	1·105
Calcic ,, ...	0·213
Potassic ,, ...	6·413
Sodic ,, ...	0·157
Water	0·508
	99·898

These results do not agree with the composition of the mineral as given in my analyses, in Mr. Bell's communication (p. 28), of the substance as found at Kean-na-Binn and Lua Yayi, nor with the Ballater substance, but are intermediate between the two. This I look upon as further proof that the mineral has no very defined chemical formula, but can be produced in the presence of an excess of silica, giving complex silicates. This body would fall under the title of "Siliceous Agalmatolite."

Digitized by Google

On some New Localities for the Mineral Diatomite, with Notes on the Chemical Composition of the Specimens exhibited.

By W. Ivison Macadam, F.C.S., F.I.C., Professor of Chemistry, New Veterinary College, Edinburgh, &c.

[Read May 21st, 1886.]

IN my previous papers on this subject* I have detailed various localities in which the mineral Diatomite has been found. Since the dates on which my papers were read various other localities have been discovered for the mineral, and I now beg to lay the details before the Society. The new samples are four in number, and are from—

1.—Golspie, Sutherlandshire.

2.—Loch Osabhat, Tolsta, Lewes.

3.—Auchnerran, Aberdeenshire.

4.—Presswhin, Aberdeenshire.

A fifth sample of a nodular mass from the Diatomite of Loch Kinnord, Aberdeenshire, has been analysed, and the results are included in this paper.

No. 1 Sample, from Golspie, was obtained by the Rev. J. M. Joass. The mineral is of a light yellow colour and encloses the ordinary plant remains common to these deposits.

No. 2 Sample, from Loch Osabhat, Lewes, was obtained from Mr. William Morrison, of Dingwall, who brought it from the deposit. The locality is described as covering the bottom of a drained loch (Loch Osabhat), and to be about 1½ acres in extent. The depth of the deposit is about 11½ feet, and after deducting about 4 feet of dark peaty stuff, we have about 7½ feet of the pure deposit. At the edges of the basin the deposit thins out to 1½ feet. When freshly cut the material gives off a disagreeable fœtid odour, but on drying the smell disappears and the colour changes from a dark brown to a light drab. Mr. Morrison calculates the bulk of the material at 7,500 square yards, which will be equivalent to about 10,000 tons weight. One cubic foot weighs about 54 lbs., which is equal to 13 cwts. per cubic yard. The loch was drained in 1874.

* *Trans. E. Geo. Soc.* Vol. IV. Pt. 3, and Vol. VI. Pt. 1.

Digitized by Google

No. 3 Sample is from Auchnerran, in the parish of Logie-Coldstone, Aberdeenshire; and

No. 4 Sample from Presswhin, Logie-Coldstone.

This latter deposit is at an altitude of 2,100 feet.

The *fifth sample* is of a dark brown, almost black, colour, very compact, and difficult to cut with the knife. It, however, contains a considerable proportion of organic matter; and, beyond the colour and the large proportion of iron present, it does not differ much from the other samples.

These compact masses give rise to considerable difficulty when the Diatomite is to be employed for dynamite manufacture; for during the preliminary process of roasting, to get rid of the organic constituents and water, these masses fuse and cause both loss of time and material. The large proportion of iron would not in itself be objectionable; for, as I have previously stated, the higher coloured dynamites are preferred by the miners—the colour being supposed to indicate strength,—but the fusibility of the mass renders the calcined residue worthless on account of its compact nature and small absorbing power. Kilns are now erected in Aberdeenshire, on the sites of these deposits; the iron nodules will be thrown aside, and a consequent saving of carriage effected. The market value of the Diatomite is about £4 per ton in the crude condition on truck at the nearest railway station. Kieselguhr fetches about £3 6s. per ton at the works.

The analyses of the samples are given in Tables A, B and C.

The Golspie sample contains a small proportion of organic constituents and corresponding increase of siliceous matter. It is, however, somewhat compact and not quite so absorbent as some of the other samples. Sand particles are also present, and although not in great quantity, would cause extra trouble and expense in purification preliminary to the use of the material either for dynamite or ultramarine.

The Loch Osabhat sample has a somewhat similar composition but is more open and porous, which, taken along with greater freedom from sand particles, renders the deposit of greater commercial value for an absorbent.

The Auchnerran sample is more of the character of the Black Moss and Kinnord samples described in my previous papers, having a considerable proportion of fibrous stems of reeds and water-plants embedded in the mass, which give binding power sufficient to allow of the body being "cast" like peats and regularly stacked to dry. These advantages in handling make this locality a valuable one, and, provided roads are available or the hill sides are sufficiently smooth for the peat sledge, then the material should be put in the market at a small cost. Moreover, the large proportion of

Digitized by Google

organic matter means that on calcination a more open and porous mass be obtained, and a higher class absorbent. I look upon this Auchnerr deposit as one of the most valuable yet discovered. Even better, howeve is the Presswhin sample, which, with fully ten per cent. less organic matter, is more open and porous than the Auchnerran material. It is also of a light drab colour, and has all the other characteristics of those Aberdeenshire deposits.

All of the above four samples yield to ether more or less chlorophyll, the green colouring matter of growing plants.

The last sample—the nodule from Kinnord—gives, on calcination, a bright red highly ferruginous ash, and, from the proportion of iron present, is very much more dense than any of the other samples and quite unfit to be used for either dynamite or ultramarine.

The proportion of diatomaceous matter is large in all the samples with the exception of that from Sutherland. This is a rather curious point, for this sample is one of the lightest in colour we have as yet had in our hands. On examination of the sample, however, it will be readily noticed that the iron, although not mixed throughout the mass, is concentrated in little particles, and has evidently been formed by the oxidation of spathic ore or from the decomposition of pyrites by means of organic matter. The Loch Osabhat sample is very similar in composition, and the remarks made as to the previous sample will be equally applicable to this deposit.

The agglomeration of iron as shown in the Kinnord nodule is interesting, and may point to a possible means of the formation of bog iron ore. It will be noticed that the other constituents of mineral origin are not in excess, and that even the allied alumina is small in quantity.

I have laid these few remarks before the Society in the endeavour to keep abreast of the age, and as proof of the statement made by me in my last paper that these deposits, although now of limited number and limited extent, only required the impetus of commercial value to lead to the discovery of fresh beds, and that from the various notices of diatomaceæ in the microscopical and other journals the localities would be neither few nor of small extent.

Digitized by Google

A.—Analysis of Samples as received.

	Sutherland.	Lewes. Grest.	Aberdeenshire. Auchnerran.	Aberdeenshire. Presswhin.	Ball from Kinnord Deposit, Aberdeenshire.
Moisture	7·92		10·64	12·60	10·61	12·48
Organic Matter (Soluble in Ether) Chlorophyll	12·64	13·875	1·32	0·61	0·32	0·07
Organic Matter (Cellulose, &c.)			11·04	37·67	27·92	51·04
Inorganic Constituents	80·04	86·125	77·02	49·08	61·16	36·21
	100·00	100·000	100·02	99·96	100·01	99·80

B.—Analyses calculated free from Moisture.

Organic Matter Soluble in Ether, Chlorophyll, &c.	13·08	13·874	1·47	0·70	0·35	0·08
Organic Matter Cellulose, &c.			12·35	43·12	31·23	58·31
Inorganic Constituents	86·92	86·125	86·17	56·18	68·29	41·37
	100·00	99·999	99·99	100·00	99·87	99·76

Digitized by Google

	Sutherland		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Soluble in Water.							
[illegible] Oxide	[illegible]						
[illegible] Magnesic ,, ...	[illegible]						
Potassic ,, } Sodic ,, }	[illegible]						
Sulphuric Anhydride ...	[illegible]						
		[illegible]					
II. *Soluble in Hydric Chloride.*							
Ferric Oxide	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aluminic ,, ...	[illegible]		[illegible]				
Calcic ,, ...	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
Magnesic ,, ...	[illegible]						
Alkalies, &c.	[illegible]						
Soluble Silica	[illegible]						
		[illegible]					
III. *Silicates decomposed by Hydric Fluoride.*							
Ferric Oxide	0·442						
Aluminic ,, ...	0·516						
Calcic ,, ...	0·187						
Magnesic ,, &c. ...	0·098						
		1·243					
Silica, mostly Diatoms ...		82·088	94·495	90·867	96·574	95·725	87·821
		99·197					

Diatomaceous Deposits in Skye.

PART I.—DESCRIPTIVE. By J. S. GRANT WILSON, H.M. Geological Survey.

PART II.—CHEMICAL. By W. IVISON MACADAM, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, and Lecturer on Chemistry, School of Medicine, Edinburgh.

[Read May 21st, 1886.]

PART I.—DESCRIPTIVE.

CONTENTS.

Introduction.

I. *The Diatomite of Cuithir.*—1. Topography. 2. Area of deposit. 3. Thickness. 4. Calculated number of tons of diatomite. 5. Diatomite found in ground above the swamp—water of loch probably stood at a higher level. 6. Quality and conditions under which deposit took place.

II. *The Diatomite of Loch Monkstadt.*—1. Topography. 2. Area of deposit. 3. Thickness. 4. Conditions prevailing during deposition.

III. *Other Localities where Diatomite has been found.*

INTRODUCTION.

IN the following pages we propose to give a short description of the recent discovery of diatomite in Skye. The portion of ground that has been explored for the deposit lies at the north end of the Island, and forms the estate of Colonel Fraser, of Kilmuir. The area is about 58 square miles, and within these limits the diatomite has been found in large quantities at two localities. As the situation of these and the conditions under which the deposition took place are in both cases very different, they will be described separately.

I. LOCH CUITHIR (QUIRE).

1. Topography.—The north end of Skye is divided into two nearly equal portions by a well-marked range of hills which trend north and south. The Sgurr Moor terminates this ridge on the north, while southwards from this point it presents a very bold escarpment to the east, and includes, among

Digitized by Google

numerous picturesque rock masses, the famous Quirang. This escarpment is almost entirely composed of beds of basalt and volcanic ash dipping gently to the west. On the north-east side of Creag-a-Lain the basaltic cliffs have succumbed more rapidly to the various denuding agencies that have been at work, and the result has been the production of a magnificent "corrie" almost circular in form. This depression is flanked by projecting masses of rock that have yielded more slowly to the agents that formed the rest of the escarpment. The centre of the corrie of Cuithir is occupied by a small loch of the same name. This sheet of water is small and shallow, and lies at the north-east edge of a well-marked circular depression, the remaining portion of which is a soft marsh. Below this marsh has been found the largest deposit of diatomite as yet discovered in Skye. The sides of this rock basin are from 15 to 20 feet above the level of the water, and every where the slope is steep and appears to be entirely composed of basalt. The various small streams that drain off the sides of the "corrie" enter the basin at the south-west corner, and the marsh in this direction continues for some distance between two of the burns.

2. Area of Diatomite Deposits.—The total area of the swamp and tarn, calculated from the ordnance 6 inch scale, is about 24 acres.

3. Depth of Diatomite.—In order to form an approximate idea of the thickness of the diatomite over the area, a borer 12 feet in length was used, and at the bottom of several of the bores an 18 foot iron rod was inserted, and in one case only did it touch the bottom; over portion of the marsh ground; it was impossible to put down any bores on account of the boggy nature of the surface. To the south-west of the lake 19 bores were put down with the following general results:—These bores proved the average thickness of the turf and peat lying above the diatomite to be 3 feet 8 inches. No intervening beds of sand or silt were met with, but the borer passed directly into diatomite and showed an average thickness of at least 8 feet 4 inches of that substance over the whole area bored. Further, the iron rod above-mentioned as 18 feet long was used to probe these bores, and in only one case, and that close to the edge of the basin, did it touch the bottom. Assuming, then, that the total depth is only 18 feet, this leaves a thickness of 14 feet 4 inches of diatomite. Future bores will no doubt show that the diatomite has a greater thickness than 18 feet, and this is rendered very probable by the uniform steepness of the sides of this basin. The flat ground beyond the circular basin and between the two burns was only bored to the depth of 12 feet, and nowhere was the bottom reached. The average thickness of peat cover was found to be 3 feet 10 inches, leaving 8 feet 2 inches of diatomite.

Digitized by Google

4. Calculated Number of Tons.—In working a similar deposit on Lord Aberdeen's estate at Tarland, it was found in practice that it took 6 cubic yards of the raw material to form a kiln-dried ton.* Calculated on this basis, and with a necessary allowance for shrinkage when the ground is drained, there are at least 72,000 tons of diatomite lying in this portion of the ground.

5. Diatomite found in Ground above the Swamp.—The flat between the burns is surrounded on the south and west sides by rough, hillocky ground, covered with heather, where diatomite has also been found. This portion of the deposit may be due to the small streams which empty themselves at this point into the swamp; or, on the other hand, the water of the loch may have stood at a higher level than it does at present. That this change of level has taken place is proved by the fact that a small patch of diatomite lies to the south of the large circular depression, and rests on the sharp rock slope that forms the side of the basin. The present outlet of the loch has a very artificial appearance, and if it were closed the surface of the water would be 15 feet higher than it now is, quite sufficient to submerge the greater portion of the rough ground.

6. Quality of Deposit.—The wet samples brought up by the borer showed that the top portion of the deposit had a bright green tint. This colour is due to chlorophyll and can be extracted by ether. A few feet down from the surface this colour usually changed to a light grey, or brown. When dried for some hours in an oven these different colours all disappeared, the samples either becoming chalk-coloured or creamy-white. The purity of this diatomite at Cuithir is very remarkable, as none of the bores show any intercalated bands of sand or silt, and the material itself contained no trace of grit. This freedom from any admixture of foreign matter is doubtless due to the position it occupies. The small streams that drain into the swamp are fed by springs which rise at the foot of the basaltic cliffs that form the walls of the "corrie." None of these streams run over peaty ground, so that the water during the period of deposition must have reached the lake in a state of great purity. The climatic conditions that prevailed during the time when the diatom forming plants flourished must have been peculiarly favourable to their growth, and in addition to the situation of the lake, sheltered on every side, must have contributed in no small degree to the accumulation of so large a deposit.

The streams all originating in springs, a constant amount of water would flow along them, and they would not be liable to sudden floods.

---

* *Trans. Geol. Soc. of Edin.* Vol. IV. p. 210.

Digitized by Google

The best gathering places for living diatoms are usually to be met with where springs issue from the ground. It is probable, therefore, that a large proportion of the diatoms did not live in the loch, but existed in the springs and burns, and were only swept into the loch afterwards. The "corrie" being almost destitute of any drift-deposit, the only foreign matter carried down by the burns consists of rock detritus, and this has been precipitated at once in the form of cones when they entered the basin before the present partial drainage of the loch. The diatoms, from their minute size and consequent lightness, would be much longer held in suspension, and thus distributed equally over the rock basin. The diatomite of Loch Cuithir was also found to contain fewer species of diatoms than similar deposits in Skye, where there is a considerable admixture of foreign matter. The fewer number of species obtained from Cuithir is doubtless due to the more equable conditions kept up by the springs which fed the loch.

The covering of peat that now lies above the diatomite has grown since the lowering of the surface of the water. When this took place there would only remain a few feet of water above the diatomite, and the various peat-forming plants and mosses with their rapid growth would soon convert the crystal clear lake into its present condition of swamp and tarn.

II. Loch Monkstadt.

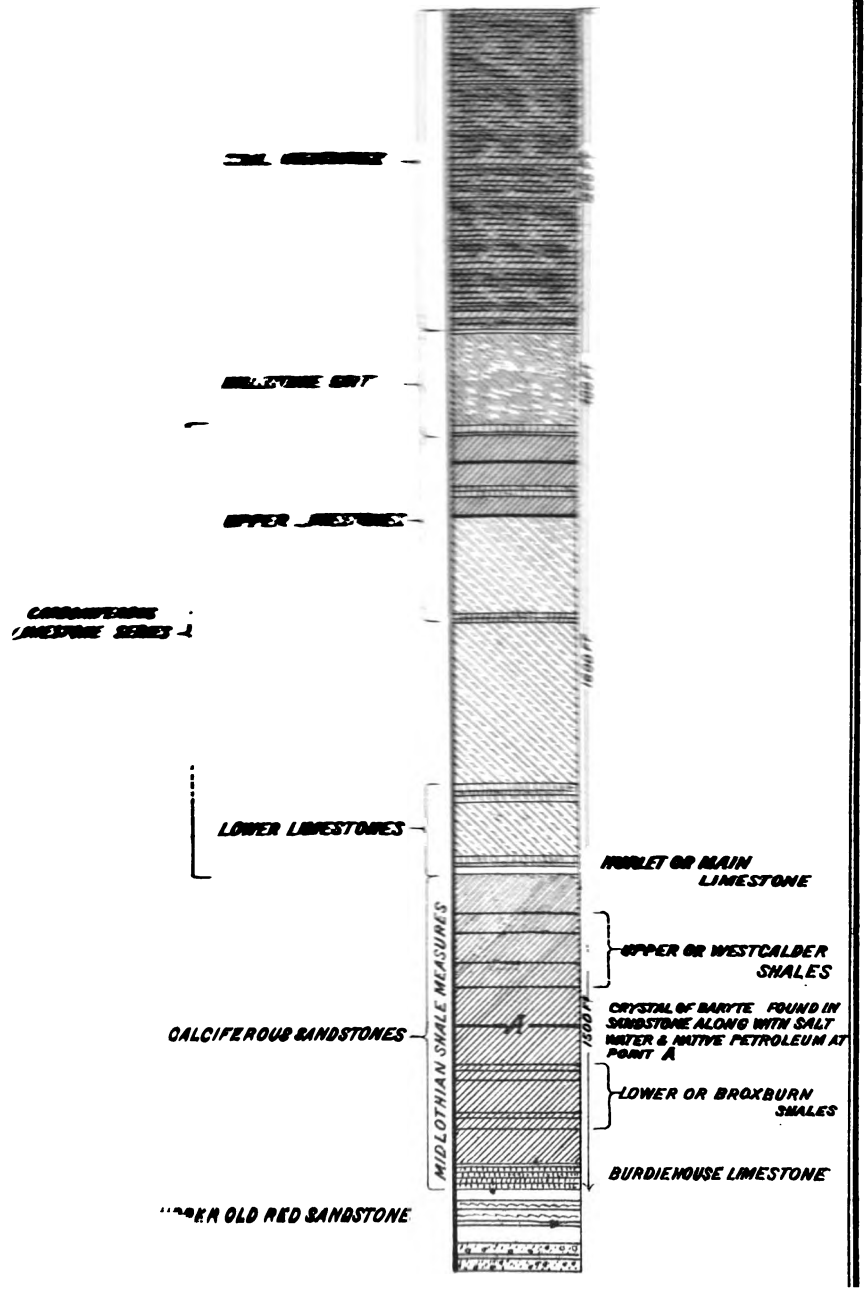
1. Topography.—To the north-west of Cuithir and in close proximity to the western seaboard lies the site of what was once the Loch of Monkstadt. A good many years ago the loch was drained by a large ditch which was cut from sea level at Camas More to the northern edge of the loch, a distance very little short of a mile. The former site of the loch, about 70 feet above sea level, is now a large flat of fairly well drained ground, all under pasture, and about half a square mile in extent. In outline it forms a rough triangle, with its apex pointing to the south-east and its base facing the north-west. Through the centre of this meadow land runs the main drainage level, and alongside this a series of bores were put down.

Thickness.—These showed that the deposit of diatomite occurred in a very irregular manner. At the south end of the flat it was almost entirely wanting, and when present was very much mixed with sand and mud. In a drain to the north of the old ruins of the monastery, about 1 foot 6 inches is seen immediately below the surface, and from this point to the north-west corner of the loch its position was proved by boring. The cover of mud, turf and peat varies in thickness from 1 to

Digitized by Google

Digitized by Google

GENERAL SECTION OF STRATA
MIDLOTHIAN.



Digitized by Google

5 feet, with a corresponding range in the thickness of the diatomite. The deposit is sometimes mixed with fine mud and silt, and in one instance a bed of sand occurs in the centre of 8 feet of diatomite.

Conditions prevailing during the Deposition of the Diatomite.—The water that drains into the loch enters at the south-east corner by several burns. These all flow off or through peat, and this is evidently the reason why the diatomite, when present over the upper portion of the basin, is always mixed with fine silt or mud. The area between the old monastery and the north-west corner would be the part farthest removed from the disturbing influences, and it is here that the diatomite is found in its greatest thickness and purity. As compared with Cuithir, the quality of the Monkstadt deposit is inferior, but it is quite equal to the German supply from the "Kieselguhr." Samples from the various bores all contained a little grit and particles of mica. When these were dried they had a darkish grey colour, and in proportion were much heavier than similar specimens from Cuithir.

III. Other Localities where Diatomite has been found.

Loch Mealt.—Very good diatomite has been found under the marsh ground that fringes the western margin of the loch. It is covered with 10 feet of peat close to the edge of the water, and between this point and the landward side of the marsh a thin covering is spread over the rocky bottom as it rises shorewards.

Sartil.—The locality is situated two miles to the west of Staffin, on the Uig Road, and the deposit is a very irregular one. The diatomite is found in rough, hillocky ground, very similar to that surrounding a portion of the swamp at Loch Cuithir.

Loch Cleat is a small loch lying to the east of Duntulm Bay. Diatomite of very good quality has been got below the swamp that borders the lake.

Loch Snuisdale.—This loch lies midway between Monkstadt and Cuithir, and diatomite has been found below a peat-moss a little to the west of the loch, and about 500 feet above sea-level.

Glen Uig.—A small deposit on the right hand of the glen. The diatomite lies on a slope and is of no extent.

Part II.—Chemical.

The annexed table of analyses shows the chemical composition and absorptive value of the samples obtained from the various deposits.

With the single exception of the No. 1 Monkstadt sample, the proportion of organic matter is small, being only 4½ per cent. of the dried

Digitized by Google

I. *Analysis of Sample as received:—*

	"Quire." *No. 1.*	"Quire." *Edge.*	"Quire." *Centre.*	"Sartil." ——	"Loch-snuisdale." ——	"Monk-stadt." No. 1.	"Monk-stadt." No. 2.	"Uig." ——
Moisture	6·921	8·240	6·405	8·466	7·417	10·106	8·602	8·164
Organic Matter... ...	4·246	9·690	4·149	7·134	4·291	20·685	10·402	10·463
Ferric Oxide	2·679	1·271	0·673	3·079	7·189	8·211	4·367	3·511
Lime, &c.	0·521	0·805	0·041	0·685	3·525	3·746	0·854	0·501
Silica (diatoms) ...	85·633	79·994	88·732	80·636	77·578	57·252	75·775	77·361
	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000

II. *Calculated free from Moisture:—*

Organic Matter ...	4·561	10·560	4·432	7·794	4·634	23·010	11·381	11·393
Ferric Oxide	2·878	1·385	0·719	3·363	7·753	9·134	4·778	3·823
Lime, &c.	0·559	0·877	0·043	0·748	3·807	4·167	0·934	0·545
Silica (diatoms) ...	92·000	87·177	94·804	88·094	83·792	63·686	82·906	84·238
	99·998	99·999	99·998	99·999	99·986	99·997	99·999	99·999

III. *Results after Calcination:—*

Ferric Oxide	3·015	1·548	0·752	3·647	8·142	11·864	5·391	4·314
Lime, &c.	0·585	0·980	0·045	0·811	3·992	5·412	1·054	0·615
Silica (diatoms) ...	96·397	97·469	99·200	95·540	87·865	82·723	93·554	95·069
	99·997	99·997	99·997	99·998	99·999	99·999	99·999	99·998

IV. *Absorptive Value:—*

100 parts of Calcined Material become when saturated with water ...	369	356	397	284	327	359	266	301

Digitized by Google

material, as obtained from Quire and Lochsuisdale, 7¾ per cent. in Sartil, and from 10 to 11 per cent. in the Monkstadt No. 2, in Uig, and at the side of Quire deposit.

Ferruginous impurity is practically absent in the central part of the Quire deposit (0·71 per cent.), but at other parts of the same basin the quantity was found to be from 1·3 to 2·8 per cent. In the remaining deposits we find 3·3 per cent. in Sartil, 3·8 per cent. in Uig, 7·7 per cent. in Lochsnuisdale, and from 4·7 to 9·1 per cent. in Monkstadt.

The value of the material for absorbing fluids such as nitro-glycerine is also high. 100 parts of the calcined substance take up of water from 166 parts to 297 parts, or from 1½ to 3 times its weight.

The Quire central zone will be found to be very valuable for the manufacture of ultramarine, and other uses where iron is objectionable, whilst the freedom from sharp sand renders the remaining deposits valuable for the various manufactures where a small proportion of iron is not objectionable.

Digitized by Google

On the Chemical Composition of the Mineral Bruiachite, found by Mr. Thomas D. Wallace, of Inverness, at Loch Bhruithaich, Inverness-shire.

By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read May 21st, 1886.]

In a paper read before this Society on June 16th, 1885,* Mr. Wallace drew attention to this mineral as being found at Loch Bhruithaich, and stated that it was obtained incrusting Barytes.

The mineral is clear, beautifully crystalline, with a tendency to a bluish tinge of colour, and very friable.

The analyses gave the following results as the average of six tests :—

Calcic Oxide	...	87·045
Sodic ,,	...	1·697
Ferric ,,	...	0·595
Fluorine ...	...	10·006
Silica ...	...	0·542
		99·885

We propose to call this mineral Bruiachite.

* *The Mineralogical Magazine and Journal of the Mineralogical Society*, Vol. VI. page 169.

Digitized by Google

Abstracts and Notes.

Vom Rath (*Festschrift des Ver. für Naturkunde.* Cassel, 1886) describes another crystal of the Quartz from Alexander Co., N. Carolina, which has been the subject of a previous paper by him (see this Journal, Vol. VI. p. 146). The crystal is compounded of two left-handed individuals, and bears a number of new faces. Five of these are in the zone *yr*, that is to say between the faces 5 P $\frac{5}{4}$ = (10 . $\bar{2}$. $\bar{5}$) and R = (100); two in the zone between R = (100) and ∞R = (11$\bar{2}$); and there are also several other new faces which do not lie in the principal zones, but belong to the group called "faces isolées" by Des Cloizeaux.

A second paper by the same author deals with the Andesite from Mount Arcuentu, in Sardinia. This mineral has an axial angle γ of almost exactly 90°, so that it occupies a mean position between Albite and Anorthite; and it was found to be twinned in accordance with no less than four laws, one of which is perhaps new. They are (1) the "Albite law," *i.e.* twin axis normal to the brachy-pinakoid, composition parallel to that face; (2) the "Carlsbad law," *i.e.* twin axis the prism edge or vertical axis, composition parallel to the brachy-pinakoid; (3) the "Pericline law," *i.e.*, twin axis the macro-diagonal, so that the individuals interpenetrate and unite in the Rhombic Section, of which the significance was pointed out by Prof. vom Rath in 1876; and (4) twin axis the brachy-diagonal, composition parallel to the basal plane. The last has been mentioned by Des Cloizeaux in his *Manuel de Minéralogie*, but was based upon doubtful evidence in the cases referred to by him; the law is to be regarded in all probability as characteristic of Andesite.

A. Renard (*Bull. Ac. Belg.* IX. p. 547) examines the optical characters of Ludwigite with the polarising microscope, and concludes that it is strongly dichroic, that it is biaxial and probably crystallises in the orthorhombic system, and that the plane of the optic axis is perpendicular to the direction in which the fibres are extended.

E. Rethwisch (*Neues Jahrb.* IV. *Beilage Band*, p. 81) gives a complete summary of the facts which have been at present published concerning Red Silver, including a list of the literature, a full table of crystallographic forms with their angles, and a history of the chemical work which has been done upon the mineral: to this are added four new

Digitized by Google

analyses, accompanied by crystallographic measurements of the specimens analysed, as follows:—

	Percentage of Arsenic.	Rhombohedron Angle.	Specific Gravity.
Pure Proustite from Chanarcillo	15·03	72°10′10″	5·5553
Pyrargyrite from Andreasberg ...	8·01	71°22′27″	5·716
Pyrargyrite from Freiberg	2·62	71°21′30″	5·754
Pure Pyragyrite from Andreasberg	0	71°12′58″	5·871

E. Scacchi (*Atti Acad. Lincei*, II. p. 182) describes crystals of Garnet from Tiriolo, in Calabria, dodecahedra having their edges truncated by the icositetrahedron {211}, while the edges made by faces of the latter with the dodecahedron faces are bevilled by the forms {431} and {541}; of these the latter is not only new for Garnet, but was not hitherto observed on any mineral belonging to the cubic system.

E. Scacchi (*Atti Acad. Lincei*, II. p. 183) gives a crystallographic and chemical determination of altered Cordierite (pinite) which occurs in liparite at Rocca Tederighi, in Tuscany. The mineral is found in green prisms from 3 to 8 mm. in length, which are a combination of the pinakoids, and two prisms, the basal plane, two pyramids, and a brachydome. As the mean of two analyses the author obtained—

SiO_2	49·65
Al_2O_3	27·41
Fe_2O_3	8·89
CaO	3·95
MgO	1·23
H_2O	8·38
	99·51

so that the mineral may be called a normal Pinite; the measured angles agree approximately with those of Des Cloizeaux.

The Theory of Twins. (*Bull. Société Minéralogique*, VIII. p. 452).—M. Mallard considers twin-crystals under the two distinct heads of (1) *Juxtaposition twins* or *macles*, in which the union is along a plane of the crystal; (2) *Interpenetration twins*, in which the individuals generally pass into one another and may have no regular surface of union. His method of regarding twins is based upon a distinction between the *point-system* (*système réticulaire*) or geometrical network formed by points occupying the positions of the centres of mass of the crystal molecules, and the

Digitized by Google

molecule-system (*édifice crystallin*), or actual crystalline network in which the points of the reticular system are replaced by the properly orientated molecules. The two semi-forms derived from a crystal form are supposed to have the same point-system but different molecule-systems, in other words their molecules occupy similar positions but have different orientations.

The following general laws are then enunciated—(1) Juxtaposition-twins; *the reticular systems of the component crystals are symmetric about the twin-plane;* here two cases may arise, (*a*) in holohedral crystals the twin-plane is a plane of actual symmetry; (*b*) in hemihedral crystals the molecule systems may be either the same or complementary; that is to say, according to the orientation of the molecules to a semi-form on one side of the twin-plane will correspond either the same or the complementary semi-form on the other; the twins may therefore be either symmetric or non-symmetric. M. Mallard proposes to abandon the idea of hemitropy, since to describe a twin it is enough to indicate the twin-plane, and to state whether the growth is symmetric or non-symmetric. (2) Interpenetration twins; here one crystal is derived from the other by turning through a certain angle about a crystal line as axis, and the general law is laid down that *this axis is always an axis of abortive symmetry or of pseudo-symmetry;* in other words, the individuals in their positions of intergrowth have either the same or nearly the same point-system.

Finally, a physical explanation of the phenomena is offered to the following effect. It may be assumed from the character of interpenetration twins that the internal equilibrium depends essentially upon the position of the molecules and not upon their directions; this being the case, we must suppose that the twin plane of a "macle" is *one along which two consecutive layers of molecules can have two very different positions of equilibrium*, account being had to the *positions* of the molecule alone.

The process of twinning is then illustrated by the action which takes place in the artificial twins of Calcite, as produced by Reusch. Just as in the latter layers of molecules parallel to the obtuse rhombohedron can be made to slide over one another and adopt a new position of equilibrium, so in the natural twinning of any mineral a crystal plane may by some accident be deposited in its second (or twin) position of equilibrium. Upon this the second crystal may then be developed either in parallel or twin position; in the latter case it must be assumed that the displacement of the plane is accompanied by a suitable change in the orientation of the molecules. The twin plane is generally one of simple indices, in other

Digitized by Google

words of great reticular density or parallel to a system of planes which are relatively widely separated from one another.

M. E. Mallard (*Bull. Société Minéralogique*, IX. p. 54) reviews the objections which have been brought against the theory of the optical anomalies of crystals propounded by him 10 years ago, and criticises the alternative theories which have been advanced by Klein, Rosenbusch, and others.

In defending his own views the author contends that in those cases where the optical properties of different parts of a crystal are the same with different positions, in other words where they can be referred to the same ellipsoid of elasticity, only differently orientated (*e.g.* in Uwarowite and Boracite), his theory is simply a translation of the observed facts into crystallographic language. Where, on the other hand, the different parts cannot apparently be referred to the same ellipsoid, but seem to be optically distinct, their dissimilarity is to be explained in accordance with the theory as due to the overlapping of a number of parts differently orientated, each belonging to one of the individuals which, by their regular intergrowth, build up the crystal. This the author supposes to be the case with Perofskite and Analcime.

As regards the alternative theories—some investigators trace the double refraction of cubic crystals and the other anomalies to internal tensions due to shrinkage on cooling; this view is condemned by the facts (1) that the transition between dissimilar parts is not gradual, as it should be if there is internal equilibrium, and as it is in the case of unannealed glass; and (2) that these effects of cooling can only be produced experimentally in precisely those substances which are not crystalline, viz. glass, gelatine, &c.

C. Klein has supposed that when Boracite crystallises an external shell is first formed, and that this exerts a pressure upon the internal crystalline material; to which M. Mallard replies that in this respect all crystals would be expected to behave in the same way. Brauns has suggested that internal tensions are produced by the mutual action of different but isomorphous molecules united in the same crystal; in answer to which it is objected that many substances which are undoubtedly isomorphous mixtures exhibit no optical anomalies. Latterly Klein has considerably modified his views, and in certain cases accepts the explanation of Mallard as describing the present structure of crystals whose original constitution is only indicated by their condition at high temperatures; Boracite, for instance, is regarded by him as at present orthorhombic, but originally cubic (see this Journal, Vol. VI. p. 193). Such a view, however, raises the question why, if the substance was not essentially orthorhombic, the

Digitized by Google

component crystals have only six different orientations, namely those corresponding to the six binary axes of the cube. Rosenbusch holds yet another opinion, and regards crystals of Leucite at the ordinary temperature as in a state of tension due to their incipient passage from the original cubic structure to a new stable molecular arrangement which is still unknown to us, so that in their present condition they are scarcely true crystals. Mallard, on the other hand, supposes that Leucite behaves in the same way as Boracite, the only difference being that twin lamellæ are in the former produced more easily and in greater number than in the latter.

Under the name of *Arsenolamprite*, Dr. C. Hintze, of Bonn, describes (*Zeits. f. Min.*, Vol. XI., 1886, 638), a mineral which he regards as identical with the so-called *arsenglanz* of Breithaupt, but which has not been hitherto looked upon as possessed of sufficiently distinctive characters to rank as a species. Analyses of two specimens yielded Dr. Klinger :—

Arsenic	98·14	98·48
Iron	1·92	1·00
Silica	0·55	0·05
	99·61	99·48

Density =5·80; taken by pycnometer, 5·54, which latter corresponds to that given by Breithaupt to the Saxony mineral. This, however, contained bismuth, which is absent in these specimens from Chili. Hardness, slightly more than that of gypsum. Lustre, bright metallic, hence its name, from λαμπρό = shining, structure foliated columnar, with a well-defined cleavage; colour, lead-grey inclining to bluish; streak, black. The author considers from its single cleavage that it is certainly not cubic in its crystallisation, and it is improbable that it should be rhombohedral or tetragonal, and that it may belong to one of the three other systems. It differs from rhombohedral arsenic in lustre, density, hardness, and structure, and may be a special modification of arsenic, comparable to the two forms of carbon, viz. graphite and diamond.

A New Mineral and a New Element.—In the year 1885, a rich silver ore of unusual appearance was found at the Himmelsfürst Mine, Freiberg, Saxony. A. Weisbach marked it as a new species and named it Argyrodite. According to a blowpipe examination by Th. Richter, it contained a small amount of mercury, but which Winkler, who analysed it (*Ber. d. Deutsch. Chem. Ges.*, 19te Jahrg., No. 8, p. 210), showed to be only 0·21 per cent. He was, however, in each analysis confronted with a loss of from 6 to 7 per cent., which could not be accounted for. After much troublesome research he was enabled to announce the discovery of a new metallic

Digitized by Google

element which he has named *Germanium*. Weisbach (*Neues Jahrb. f. Min.*, 1886, B. II. p 67) gives the following characters of this new and interesting species. Lustre, metallic; colour on crystal-faces steel-grey on a fresh fracture, and to reddish, and sometimes violet as in Erubescite; streak, grey-black, shining; opaque. Hardness, 2·5, specific gravity 6·085 to 6·111; brittle; crystals show no cleavage; fracture, somewhat conchoidal. Crystallises in the monoclinic system, sometimes in twins and "three-lings," but mostly very minute and indistinct, being frequently aggregated in wart-like and kidney-shaped groups. The analysis showed 75 per cent. of silver and 7 per cent. of germanium, which is to be represented by the symbol Ge.

G. Flink (*Zeits. f. Kryst.*, XI., 1886, pp. 449-530) draws the following conclusions from an elaborate study of the Pyroxene minerals of Sweden.

In the varieties of Diopside it is proved for the first time that an increase in the proportion of iron is always associated with a regular increase in the axial angle β, which varies from 74°34¼′ in those which are richest in iron to 74°12¾′ in those which contain least iron; on the other hand, the examination of Schefferite and Rhodonite shows that the presence of manganese has precisely the opposite effect, and to a much greater degree. Thus:—

	MnO per cent.	β
Diopside	0·00	74°11′
Schefferite	8·32	73°53′
Rhodonite	41·88	71°15¾′

When the proportion of manganese exceeds a certain amount, the system changes from oblique to anorthic (Rhodonite), though it is not yet ascertained what is the exact percentage of manganese for which the transition takes place.

The author has also studied the corresponding variations in the optical characters of these minerals, and finds that in this respect manganese and iron have the same effect, an increase in the percentage of either serving to increase the extinction angle in the plane of symmetry (angle between acute bisectrix and vertical axis) and also the angle of the optic axes. Since, however, the optical orientation of the anorthic Rhodonite is totally different from that of the oblique Pyroxenes, no direct comparison can here be made between the two groups.

One portion of the paper deals with well crystallised Schefferite from Längban and Pajsberg; the name Schefferite is used to denote those oblique Pyroxenes which are characterised by a high percentage of manganese.

Digitized by Google

THE MINERALOGICAL MAGAZINE
AND
JOURNAL
OF THE
MINERALOGICAL SOCIETY.

No. 33. DECEMBER 1886. Vol. VII.

Barytes from Addiewell, West Calder, in Midlothian.

By CHARLES O. TRECHMANN, Ph.D., F.G.S.

[Read June 22nd, 1886.]

THIS occurrence of barytes is somewhat remarkable and interesting from several aspects:—The peculiar conditions under which it seems to have been deposited, the limited quantity, and the perfection and richness of the crystallographic development.

It was found some two years ago in one of the shale pits of the Young's Paraffin Oil Company, and my friend Mr. J. S. Thomson, to whom I am indebted for two of the four or five existing specimens (of which one, I am happy to say, has been deposited in the Museum of Edinburgh), was so kind as to procure for me from the Mining Engineer of the Company a sketch of the Geological Strata of the neighbourhood, in which the position of the beds containing the crystals is indicated (Plate II.).

He writes as follows:—"The highest part of the section in that neighbourhood is the "Hurlet" or Main (carboniferous) limestone, and all depths are reckoned from this level. The crystals were found in a cavity in the sandstone at No. 15 shale pit at Addiewell; which cavity contained besides calcite, salt water, petroleum or liquid bitumen and solid bitumen or ozocerite (?)."—"It may perhaps be of interest to you to know that the presence of salt water may possibly be accounted for by the cavity where the crystals were found occurring just at sea level."

On the larger of the two specimens which I have thus been enabled to study, the crystals of barytes, accompanied by a few isolated crystals of iron pyrites, are irregularly disposed upon the bedding surface and edges of an irregular slab of "waterworn" or eroded fine-grained grey sandstone, the other side being occupied by crystals of calcite.

Digitized by Google

The barytes seem to be of two generations, of which the older, in thick tabular dull crystals of the form (001), (110), (101), (012), and about three-fourths of an inch in length, are covered by the younger transparent ones, which range in size from half-an-inch in length downwards to quite minute dimensions. On the smaller specimen no sandstone remains, and the small brilliant crystals of barytes are carried mainly on an aggregate of saddle-shaped lustrous rhombohedrons of pearlspar, among which lie covered crystals of older barytes, and an occasional speck of pyrites; while the lower surface is again occupied by a few clear calcites of the form : $(20\bar{1})$ R^3, (110) $-\frac{1}{2}$ R. The barytes crystals of the second generation are all of the same somewhat uncommon type of development, viz. elongated in the direction of the brachydiagonal axis, and governed by the forms (101) (012) (001) (010), while the smaller, perfectly limpid, crystals of some 2 mm. long show a large number of subsidiary forms, which give them in general the habit of the beautiful crystals from Chirbury, Salop ; a relationship which is the more distinctly characterised by the fact that on both of them the rare and hitherto almost unknown form E (412) is hardly ever absent.

The lustre of the faces is exceedingly perfect, so that even the smallest of them give perceptible reflections, and the measured angles of inclination approach so closely to those deduced from calculation, that the conclusion seems justified, that the rate of growth of these crystals must have been unusually slow. The impeding cause may be looked for in the presence of the mineral oil, of which considerable quantities have been taken up by many of the crystals, and which appears, under the microscope, enclosed in irregular rounded cavities, of which many again are flattened out in a direction parallel with the plane (101). The oil thus disseminated is of a brownish yellow colour, transparent, and of an intensity varying with the thickness of the layer. Each cavity contains a large gas bubble. Cubes of NaCl or crystals of other salts could not be detected.

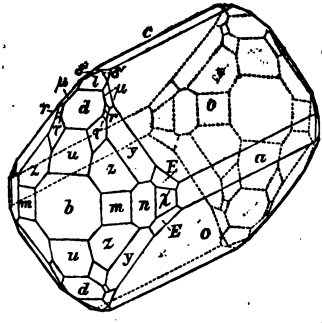


Fig. 1.

Eleven of the smallest crystals were subjected to examination, and on them a total number of 21 forms was observed, of which 6 seem to have hitherto been unknown. The distribution on each crystal is shown on Table I., the new forms being distinguished by an asterisk. Fig. 1 has been constructed as closely as possible after nature, and represents the general character of these crystals and the relative size of the principal planes.

Digitized by Google

TABLE I.

	Miller. $\bar{a} : \mathring{b} : \overset{1}{c}$	Naumann. $\mathring{a} : \bar{b} : \overset{1}{c}$	Number of Crystal.										
			1	2	3	4	5	6	7	8	9	10	11
a	100	$\infty\breve{P}\infty$	—	—		—	—	—	—	—	—	—	—
b	010	$\infty\bar{P}\infty$	—	—	—	—	—	—	—	—	—		—
c	001	0P	—	—	—	—	—	—	—	—	—	—	—
m	110	∞P	—	—	—	—	—	—	—	—	—	—	—
n	210	$\infty\breve{P}2$	—	—	—	—	—	—	—	—	—	—	—
χ	810	$\infty\breve{P}8$	—	—	—	—	—	—		—	—	—	—
o	101	$\breve{P}\infty$	—	—	—	—	—	—	—	—	—	—	—
o^7*	701	$7\breve{P}\infty$	—										
l	014	$\frac{1}{4}\bar{P}\infty$	—	—	—	—	—	—	—	—	—	—	—
$d\frac{3}{8}$*	038	$\frac{3}{8}\bar{P}\infty$	—			—	—	—		—		—	—
d	012	$\frac{1}{2}\bar{P}\infty$	—	—	—	—	—	—	—	—	—	—	—
u	011	$\bar{P}\infty$	—	—	—	—	—	—	—	—	—	—	—
z	111	P	—	—	—	—	—	—	—	—	—	—	—
r	112	$\frac{1}{2}$P	—	—	—	—		—	—	—	—	—	—
y	212	$\breve{P}2$	—	—	—	—	—	—	—	—	—	—	—
μ	214	$\frac{1}{4}\breve{P}2$	—	—	—	—	—	—	—	—	—	—	—
*P**	434	$\breve{P}\frac{1}{3}$			—								
E	412	$2\breve{P}4$	—	—	—	—	—	—		—	—	—	—
τ'*	234	$\frac{3}{4}\bar{P}\frac{3}{2}$	—	—		—	—	—		—		—	—
λ'*	123	$\frac{1}{3}\bar{P}2$							—				
σ'*	5.11.55	$\frac{1}{5}\bar{P}\frac{1}{1}$			—								

The new forms are established on the following measurements and zones, the calculated angles being deduced from the parameters determined by Helmhacker on the barytes of Svárov:—$\mathring{a} : \bar{b} : \overset{1}{c} = 0.8152 : 1 : 1.8186$ as harmonising best with my measurements.

$o^7 = (701)$, $7\breve{P}\infty$ observed as an exceedingly narrow face on crystal No. 1.

	Measured.	Calculated.
$o^7 : 001$	$= 88°55\frac{1}{2}'$	88°47'36"

$d\frac{3}{8} = (038)$, $\frac{3}{8}\bar{P}\infty$ observed on seven crystals and measured on four, as a narrow, generally somewhat rounded truncation of the edge (012) : (014).

Digitized by Google

	Measured (Mean).	Calculated.
$d\frac{1}{3} : 010$	$= 58°54'$	$58°51'24''$

maximum 60°32′ minimum 57°29′

It is an ill-defined form, tending towards the known forms (025) and (013), for which the calculated angles are respectively 57°11′46″ and 61°45′32″.

P = (434), $\breve{P}\frac{4}{3}$ once as a very narrow face in the zones (111) : (212) and (112) : (210),

	Measured (Approx.)	Calculated.
P : (014)	$= 48°8\frac{1}{2}'$	47°37′4″
P : (210)	$= 30°31\frac{1}{2}'$	31°6′58″

$r' = (234)$, $\frac{2}{3}\bar{P}\frac{2}{3}$. A well characterised form with large and well developed faces in the zones (111) : (012) and (011) : (212),

	Measured.	Calculated.
r' : 012	$= 25°19'$	25°20′30″
r' : 111	$= 13°46\frac{1}{2}'$	13°46′58½″
r' : 212	$= 24°48'$	24°46′29″

$\lambda' = (123)$, $\frac{1}{3}\bar{P}2$ once as a narrow face in the zones (101) : (011) and (012) : (111,)

	Measured.	Calculated.
λ' : 111	$= 20°33'$	20°39′16″
λ' : 011	$= 19°15\frac{1}{2}'$	19°54′23″

$\sigma' = (5.11.55)$, $\frac{1}{5}\bar{P}\frac{11}{5}$ as a small face on crystal No. 8. The simpler indices (1.2.10), $\frac{1}{5}\bar{P}2$ suggested themselves, in which case the face would have been zonal with the faces $(\bar{2}10) : (\bar{1}12) : (014)$. This was, however, not the case, the face σ' lay slightly out of the zone,

	Measured.	Calculated. for (5.11.55)	(1.2.10)
σ' : 101	$= 48°27'$	48°29′39″	47°52′16″
σ' : 014	$= 7°36\frac{1}{2}'$	7°39′21″	8°12′22″
σ' : 012	$= 21°35\frac{1}{2}'$	21°55′48″	22° 7′10″

As the number of forms recognised on this mineral has much increased since the publication of Helmhacker's monograph and the remarkable "Atlas" of Schrauf, I have ventured, with the literature at my disposal, to give in the following table a list of 94 forms, of which those which have been observed on barytes found in Britain are indicated by the letters in the first column. These consist of 24 forms given in Greg and Lettsom's Manual, and of 15 new forms characterised by an asterisk, of which 7 were observed on the barytes from Chirbury and 8 on that of Addiewell, or a total of 39 British forms.

Digitized by Google

TABLE II.

British Forms.	Miller. $\bar{a} : \breve{b} : \dot{c}$	Naumann. $\dot{a} : \bar{b} : \ddot{c}$	Helmhacker, 1871.	Schrauf, Atlas, 1872-73.	New Forms.	Locality.	Observer.
a	100	$\infty\breve{P}\infty$	1	*b*			
b	010	$\infty\bar{P}\infty$	12	*c*			
c	001	0P	22	*a*			
m	110	∞P	6	*m*			
	320	$\infty\breve{P}\frac{3}{2}$	5	*N*			
*n**	210	$\infty\breve{P}2$	4	*n*		Addiewell	
χ*	310	$\infty\breve{P}3$	3	χ		Addiewell	
	410	$\infty\breve{P}4$	2	*L*			
	450	$\infty\bar{P}\frac{5}{4}$			*h*	Telekes	Schmidt.
η	230	$\infty\bar{P}\frac{3}{2}$	7	η			
	350	$\infty\bar{P}\frac{5}{3}$	8				
λ	120	$\infty\bar{P}2$	9	λ			
	130	$\infty\bar{P}3$	10	β			
	140	$\infty\bar{P}4$	11	τ			
	108	$\frac{1}{8}\breve{P}\infty$	23	*a*			
	103	$\frac{1}{3}\breve{P}\infty$			*i*		Miers
ϕ	102	$\frac{1}{2}\breve{P}\infty$	24	ϕ			
	506	$\frac{5}{6}\breve{P}\infty$	25				
	809	$\frac{8}{9}\breve{P}\infty$		ϵ			
o	101	$\breve{P}\infty$	26	*M*			
	201	$2\breve{P}\infty$	27	*i*			
	401	$4\breve{P}\infty$			*x*	Binnenthal	Grünling
o^7*	701	$7\breve{P}_\infty$			o^7	Addiewell	
	10 0 1	$10\breve{P}\infty$			*x*	Telekes	Schmidt
	018	$\frac{1}{8}\bar{P}\infty$	21	*W*			
w	016	$\frac{1}{6}\bar{P}\infty$	20	*w*			
	015	$\frac{1}{5}\bar{P}\infty$	19	σ			
l	014	$\frac{1}{4}\bar{P}\infty$	18	*l*			
g	013	$\frac{1}{3}\bar{P}\infty$	17	*g*			
$d\frac{3}{8}$*	038	$\frac{3}{8}\bar{P}\infty$			$d\frac{3}{8}$	Addiewell	
i	025	$\frac{2}{5}\bar{P}\infty$		κ			
d	012	$\frac{1}{2}\bar{P}\infty$	16	*d*			

Digitized by Google

Table II.—*Continued.*

British Forms.	Miller. $\bar{a} : \breve{b} : c^{1}$	Naumann. $a^{c} : \bar{b} : c^{1}$	Helmhacker, 1871.	Schrauf, Atlas, 1872-78.	New Forms.	Locality.	Observer.
	058	$\frac{5}{8}\breve{P}\infty$				Pésey	Fényes
	023	$\frac{2}{3}\breve{P}\infty$	15				
*Z**	034	$\frac{3}{4}\breve{P}\infty$			*Z*	Chirbury	Miers
	0 23 24	$\frac{23}{24}\breve{P}\infty$	14				
u	011	$\breve{P}\infty$	13	*u*			
	032	$\frac{3}{2}\breve{P}\infty$		*D*			
	021	$2\breve{P}\infty$		*U*			
	1 1 20	$\frac{1}{20}$P			*e*	Telekes	Schmidt
	119	$\frac{1}{9}$P	28	*H*			
k	118	$\frac{1}{8}$P	29	*k*			
	116	$\frac{1}{6}$P	30	*F*			
v	115	$\frac{1}{5}$P	31	*v*			
q	114	$\frac{1}{4}$P	32	*q*			
f	113	$\frac{1}{3}$P	33	*f*			
r	112	$\frac{1}{2}$P	34	*r*			
	223	$\frac{2}{3}$P	35	*R*			
z	111	P	36	*z*			
	441	4P			*p*	Telekes	Schmidt
*P**	434	$\breve{P}\frac{4}{3}$			*P*	Addiewell	
y	212	$\breve{P}2$	37	*y*			
	313	$\breve{P}3$	38	*I*			
	414	$\breve{P}4$	39	ρ			
	515	$\breve{P}5$	40				
	616	$\breve{P}6$		ψ			
*Q**	15 1 15	$\breve{P}15$			*Q*	Chirbury	Miers
	211	$2\breve{P}2$	41	Σ			
	311	$3\breve{P}3$	42	Φ			
	411	$4\breve{P}4$	43	*T*			
	511	$5\breve{P}5$	44	Ξ			
ω*	432	$2\breve{P}\frac{4}{3}$			ω	Chirbury	Miers
μ	214	$\frac{1}{2}\breve{P}2$	50	μ			
	634	$\frac{3}{4}\breve{P}2$	54				

Digitized by Google

TABLE II.—*Continued.*

British Forms.	Miller. $\bar{a} : \breve{b} : \bar{c}$	Naumann. $\breve{a} : \bar{b} : \bar{c}$	Helmhacker, 1871.	Schrauf, Atlas, 1872-78.	New Forms.	Locality.	Observer.
	632	$3\breve{P}2$	53				
	316	$\frac{1}{2}\breve{P}3$	51				
s	312	$\frac{3}{2}\breve{P}3$	55	*s*			
	726	$\frac{7}{6}\breve{P}\frac{7}{2}$		ϰ			
	416	$\frac{4}{3}\breve{P}4$			*F*		Miers
*E**	412	$2\breve{P}4$	56		*E*	{ Chirbury, Addiewell }	
	514	$\frac{5}{4}\breve{P}5$		ζ			
	518	$\frac{5}{3}\breve{P}5$			*G*		Miers
	716	$\frac{7}{6}\breve{P}7$		θ			
	8 1 12	$\frac{8}{3}\breve{P}8$	52	Γ			
*Y**	19 1 18	$\frac{19}{18}\breve{P}19$			*Y*	Chirbury	Miers
Λ*	25 1 27	$\frac{25}{27}\breve{P}25$			Λ	Chirbury	Miers
	122	$\bar{P}2$	45	ν			
	133	$\bar{P}3$	46	∇			
	144	$\bar{P}4$	47	δ			
ξ*	232	$\frac{3}{2}\bar{P}\frac{3}{2}$			ξ	Chirbury	Miers
τ'*	234	$\frac{3}{4}\bar{P}\frac{3}{2}$			τ'	Addiewell	
λ'*	123	$\frac{3}{2}\bar{P}2$			λ'	Addiewell	
σ'*	5 11 55	$\frac{1}{5}\bar{P}\frac{11}{5}$			σ'	Addiewell	
	254	$\frac{5}{4}\bar{P}\frac{5}{2}$		Δ			
γ	132	$\frac{3}{2}\bar{P}3$	48	γ			
	8 11 6	$\frac{11}{6}\bar{P}\frac{11}{8}$		ι			
	7 28 24	$\frac{7}{6}\bar{P}4$	58				
	8 15 10	$\frac{3}{2}\bar{P}5$	49	*X*		{ Probably identical with the following }	
	11 55 30	$\frac{11}{8}\bar{P}5$			Π	Mittelagger	Busz
	178	$\frac{7}{8}\bar{P}7$	59				
	2 14 9	$\frac{14}{9}\bar{P}7$	57			{ Doubtless identical with the following }	
	8 56 85	$\frac{8}{5}\bar{P}7$			$\Pi_,$	Mittelagger	Busz
	196	$\frac{3}{2}\bar{P}9$		π			
	1 10 7	$\frac{10}{7}\bar{P}10$			$\Pi_{,,}$	Mittelagger	Busz

Digitized by Google

Literature consulted.

Brooke and Miller,	1852.	Phillips' Mineralogy, p. 529.
Greg and Lettsom,	1858.	Manual of Mineralogy, p. 61.
Schrauf,	1864-78.	Atlas der Krystallformen des Mineralreiches III. Taf. xxx. 1872. IV. Taf. xxxi. xxxii. 1878.
Schrauf,	1871.	Sitzungsberichte d. K. Akad. Wien. LXIV.
Helmhacker,	1872.	Ueber Baryte des Eisensteinfuehrenden Boehmischen Untersilurs. Separatabdruck aus dem XXXII. Bande der Denkschriften der K. Akad. Wien. Min. Mitth. Tschermak, 1872, p. 71.
Kokscharow,	1875.	Materialien zur Mineralogie Russlands, VII. p. 25.
Schmidt,	1882.	Zeitschrift für Krystallographie u. Mineralogie, VI. p. 554.
Miers,	1882.	Zeitschrift für Krystallographie u. Mineralogie, VI. p. 600.
Miers,	1883.	*Nature*, XXIX. pp. 29 and 124.
Woodward	„	„ „ p. 77.
Grünling,	1884.	Zeitschrift für Krystallographie u. Mineralogie, VIII. p. 248.
Busz,	1885.	Zeitschrift für Krystallographie u. Mineralogie, X. p. 32.
Fényes,	1885.	Zeitschrift für Krystallographie u. Mineralogie, X. p. 89.

Digitized by Google

Francolite, a Variety of Apatite from Levant Mine, St. Just, Cornwall.

By R. H. Solly, F.G.S., Demonstrator in Mineralogy to the University of Cambridge.

[Read June 22nd, 1886.]

THE three varieties of apatite at present known to occur in Cornwall are the sea-green limpid crystals from St. Michael's Mount and other places, the dirty-white, semi-opaque, hexagonal prisms associated with axinite from Botallack Head, and the thin hexagonal plates, described and analysed by Prof. Maskelyne and Dr. Flight as coming from a new locality, now known, however, to have been obtained by the late Mr. Talling from Fowey Consols, and previously noted from this mine by Greg and Lettsom. To these must now be added a new variety which was lately brought to me as chalybite from the deep workings of Levant Mine, St. Just. The specimens are closely analogous to those analysed by Dr. Flight, but differ slightly in chemical composition and mode of occurrence.

The crystals are in the form of small hexagonal plates, rarely more than $\frac{1}{8}$th of an inch in diameter and less than $\frac{1}{16}$th thick, vitreous lustre, limpid and slightly iron-stained, associated with curved white vitreous crystals of calcite on iron-stained quartz with a little copper pyrites. They are aggregated in a very confused manner; some are apparently twinned about the plane *x*, but the measurements obtained are not sufficiently satisfactory to establish a new twin law. The crystals usually consist of three or more individuals grown parallel to the *a* $\{10\bar{1}\}$ plane.

When the aggregations are broken up a "face of junction" is obtained, lying a little out of the zone *a*, *o*. A definite reflection could not be obtained on account of the curvature of the face. Approximate angle 40°. No crystal was found exhibiting more than one of these faces, and since the position, shape and curvature of the face, and the approximate angle obtained, was similar in a number of crystals examined, I have ventured, for want of a better name, to call this face "a face of junction," as I cannot show that it is parallel to a possible plane of the crystal.

A crystal placed between crossed nicols in a Norremberg polariscope gave the familiar broken cross, with widely separated and highly coloured rings of apatite, and with the aid of a mica plate the sign of double refraction was found to be negative.

Digitized by Google

The specific gravity was found to be 3·186.

I am indebted to Mr. Robinson, who has sent me the following account of the analyses he kindly undertook for me of the crystals of apatite. It will be seen that the Ca CO_3 is present in very similar proportions in the two analyses he made. But whether we are to consider the CO_2 as chemically combined, and therefore replacing either the P_2O_5 or F, or merely as a mechanical mixture of Ca CO_3, such as is found in varying and microscopic quantities in the apatites from Canada, is a question which cannot be settled satisfactorily, since no simple chemical formula can be given for the proportions found by Mr. Robinson.

As, however, the amount of CO_2 in these two analyses from crystals broken from various specimens agrees so closely, I feel inclined to accept Dr. Flight's view, and consider that CO_2 sometimes replaces the other acids in this mineral.

Digitized by Google

Two Analyses of Crystals of Apatite.

By Henry Robinson, M.A., Downing College, Cambridge.

BEFORE commencing the analysis I sifted the crystals to remove all small ones and dust, and then picked out, as far as possible, the hematite and every thing which differed from the general mass of crystals. By these means I obtained a very uniform sample of fair sized crystals. The whole was then finely powdered and divided into two portions, of each of which an analysis was made. I had reason to suppose that in the analysis I made previously* some of what appeared as CO_2 was really fluorine, so before making these analyses I made some experiments to see if I could arrange the strength of my acid so that while the substance was dissolved, the hydro-fluoric acid should not be given off on boiling the solution for a reasonable time to get rid of the CO_2. By using a sufficient quantity of a dilute solution of nitric acid containing 147·5 grams of HNO_3 in the litre, I succeeded in my object. All dissolved in the cold except a few particles of hematite and quartz—2·0 mgrms. from 781·75 mgrms., and on boiling the solution and drawing air through it there was no taste of any acid but CO_2; the hematite also remained undissolved. As the hematite and quartz were evidently foreign to the mineral, I deducted the amount found of them from the substance originally taken, as also I did the very small quantity of water present, 0·2 mgrms. in 781·75 mgrms. There was scarcely a trace of iron dissolved, not enough to estimate. In the first of these two analyses I evaporated the nitric acid solution, obtained after estimating the CO_2 to dryness; converted the solids into chlorides, and went through the usual process to remove silica, but none was present. The lime was precipitated as oxalate and weighed as sulphate, the phosphoric acid was estimated in the ordinary way as magnesium pyro-phosphate, the CO_2 from the loss of weight after decomposing the mineral with the dilute nitric acid already mentioned. The fluorine was estimated indirectly as follows:—I took the necessary amount of lime from that found to convert the whole of the CO_2 and P_2O_5 into carbonate and phosphate, and the remainder I calculated as fluoride. For A 948·94 mgrms. of the mineral were taken, for B 727·3 mgrms.

* *Trans. R. G. S. of Cornwall*, 1886.

Digitized by Google

	A		B	
	Mgrms.		Mgrms.	
$Ca\,CO_3$	27·0 =	2·845 o/o	21·0 =	2·887 o/o
$Ca_3\,2\,PO_4$	886·1 =	88·108 ,,	648·8 =	89·206 ,,
$Ca\,F_2$	85·8 =	9·041 ,,	62·2 =	8·552 ,,
	948·9 =	99·994	732·0 =	100·645

In B there is most likely a slight error in excess in the phosphoric acid; this brings the fluoride a little too low and the total too light. I should have said there was not more than a mere trace of chlorine present, if any.

The following analysis A was the mean analytical result obtained by Dr. Flight for francolite, and B expresses the proportions of the typical formula of apatite.

	A	B
$Ca_3\,2\,PO_4$	88·261	92·26
$Ca\,F_2$	7·688	7·74
$Ca\,CO_3$	5·104	—
$Fe\,O$ & $Mn\,O$	0·913	—
$Na_2\,O$	0·694	—
$H_2\,O$	1·593	—
	99·248	100·00

Digitized by Google

Anglesite from Portugal.

By R. H. Solly, F.G.S.., Demonstrator in Mineralogy to the University of Cambridge.

[Read June 22nd, 1886.]

THESE crystals of anglesite were given to me by Dr. Gadow, the Strickland Curator to the University of Cambridge, who obtained them while on a zoological expedition to Portugal.

They were given to him by the agents at the San Domingos copper mines near the Guadiana river in the province of Algarve, South Portugal, as crystals strange and unknown to them.

The only Portuguese localities recorded at present for anglesite are far north of these mines.

The San Domingos mines are worked in a portion of the great metallic lode or bed which stretches from the S.W. of Portugal, across the southern portion of Spain, in the province of Huelva, in an E.S.E. direction, and appearing again in a similar manner and direction on the other side of the Mediterranean in Algeria. The age of the surrounding strata is a matter of dispute. Some geologists call them Silurian, others Devonian, but F. Römer is of opinion that they belong to a low horizon of the Culm measures.* The well-known Rio Tinto and Tharsis mines are worked in this lode.

These crystals of anglesite are of a reddish honey-yellow colour, semi-transparent, with vitreous to greasy lustre, conchoidal fracture, with no apparent cleavage. H. 3. They vary in size, the largest I have being 25 mm. by 20 mm., and 14 mm. deep. The form is that of a simple rhombic prism with basal plane. The *c* (001) plane has wavy striations parallel to the intersections of the planes *c* and *a*. The *m* plane shows polysynthetic growth. On holding a crystal up to the light and viewing it through the plane *c*, layers of different shades can be seen parallel to the *m* planes. The thickness of the layers seems to be governed by the depth and breadth of the "junction faces," which are described below. Some of the *m* planes exhibit indentations forming impression or false planes, sometimes called "junction planes;" also fine deep striations giving "vicinal junction faces." One of these false faces

* *Zeitschr. d. d. geol. Gesellsch.* 1876, p. 354.

Digitized by Google

is quite smooth, and makes an angle of 39° 53′ with m, 54° 10′ with m', and 60° 38′ with c (Fig. 2). This face is only perceived to be a false or junction plane through the impossibility of assigning to it simple indices, and also through the entire absence of the other planes on the best developed edges of the crystals required by the law of symmetry. The simplest indices that can be assigned to this face are (18 81 77).

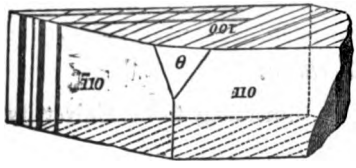


FIG. 2.

False planes formed by the impression of crystals of the same nature are well seen in the cases of some varieties of quartz and garnet, when groups of crystals of either minerals are broken asunder.

I have been unable to find any definite regularity existing either between the directions of the striations on the junction faces to the crystallographic edges of the crystal itself or to the penetrating crystal.

We ought not to be surprised that we can find no law for the above, if we take into consideration the numerous ways of aggregating observed on crystals which, as far as our knowledge goes at present, follow no law except in a few aggregations called twins. But it must be remembered that the junction faces due to the penetration of like crystals are rare, and that the general rule is that when an aggregation of crystals is broken, only a conchoidal or splintery fractured surface is obtained.

The junction faces obtained on crystals in rock masses due to the impression of different crystals, that is to say, different minerals, can be accounted for easily, as we are dealing with two distinct molecular growths, while in the above we are considering similar chemical compounds with similar molecules, endowed, as far as we know, with similar powers of affinity.

The crystals from the San Domingos mine were measured on my Fuess Goniometer, and the angle between the two best m planes gave 76° 9½′, which agrees well with the calculated values obtained by other observers, viz.

Miller	m m′	76° 22′
Kokscharow	,,	76° 16′
Krenner	,,	75° 34′

The specific gravity of the crystal weighing 317·42 grams was found to be 6·252. It was associated with a little galena, iron pyrites, and snow-white gypsum.

Scarcity of material has prevented a chemical analysis being made, which however is not needed for determination of the mineral.

Digitized by Google

On Plattnerite.

By Edward Kinch, Professor of Chemistry, Royal Agricultural College, Cirencester.

[Read June 22nd, 1886.]

THIS mineral, lead dioxide, does not seem to have been examined since it was first noticed by Breithaupt and Plattner in 1837 (*Journ. pr. Chem.* x. 508). This specimen, named "Schwerbleierz," is said to be probably from Leadhills, and the mineral is called, in the manuals of Dana and others, a doubtful species. It was named Plattnerite by Haidinger and subsequent authors.

A short time ago my friend Mr. Thos. Davies, F.G.S., of the British Museum, asked me to analyse a mineral from Leadhills, Lanarkshire, which he had had in his possession for some years, but the examination of which he had, from various causes, frequently postponed. On examination it was found to be lead dioxide—Plattnerite.

It is a black mineral, in globular or mammillated concretions, with crystalline exterior; with a velvety lustre on surfaces, the lustre of fractures being sub-metallic; fracture uneven; opaque, streak dark brown to puce colour; H. about 5; S. G. 8·54.

On heating it gives off oxygen, leaving a residue of litharge. With hydrochloric acid it gives off chlorine even in the cold, and on warming entirely dissolves, lead chloride separating out on cooling. The matrix consists mainly of lead carbonate (cerussite), with some chlorophosphate (pyromorphite); from these it was rather difficult to entirely separate the black mineral.

The prepared specimen was found to contain traces, but traces only, of water, carbon dioxide, lime, and ferric oxide.

It underwent no loss at 100° C.

On analysis of the carefully selected mineral the following results were obtained:—

Loss on ignition at a low red heat.—This loss was of oxygen with traces of carbon dioxide and of water.

·8805 gram lost ·0617 = 7·01 per cent.
·6522 ,, ,, ·0469 = 7·19 ,,

The residue from the first of these ignitions contained very small amounts of undecomposed mineral and of red lead, Pb_4O_5.

Digitized by Google

Estimation of lead protoxide.

·8805 gram gave 1·1061 $PbSO_4$ = 92·45 per cent. PbO
·616 ,, ,, ·7743 $PbSO_4$ = 92·46 ,, ,,
·5492 ,, ,, ·6562 $PbCl_2$ = 92·83 ,, ,,
·7865 ,, ,, 1·060 $PbCrO_4$ = 92·90 ,, ,,

Estimation of oxygen over that required to form PbO.—This was estimated by treating the finely powdered mineral with strong hydrochloric acid in a small flask and distilling the liberated chlorine into a strong solution of potassium iodide, and afterwards estimating the liberated iodine with a solution of sodium thiosulphate, exactly as in Bunsen's method for estimating the value of manganese ores.

The equations representing the reactions are as under :—

$$PbO_2 + 4\,HCl = PbCl_2 + 2H_2O + Cl_2$$
$$Cl_2 + 2\,KI = 2\,KCl + I_2$$
$$2\,Na_2S_2O_3,\ 5\,H_2O + I_2 = 2\,NaI + Na_2S_4O_6 + 5\,H_2O$$

·4905 gram liberated iodine = ·08081 oxygen = 6·28 per cent. oxygen
·5492 ,, ,, ,, = ·033575 ,, = 6·11 ,, ,,

One or two other methods of estimating the available oxygen were tried, but failed to give satisfactory results.

Mean of results.

Loss on ignition	7·10 per cent.
Lead protoxide, PbO, by direct determination... ...	92·66 ,,
	99·76
Equivalent to lead	86·01 ,,
Available oxygen in excess of PbO, by determination...	6·20 ,,
Water, carbon dioxide, ferric oxide, and lime... ...	traces

Lead dioxide requires

Lead	86·61 per cent.	or	Lead protoxide	93·31 per cent.
Oxygen	13·39 ,,		Oxygen	6·69 ,,
	100·00			100·00

Plattner (*loc. cit.*) found 86·2 per cent. of lead.

These results leave no doubt of its identity with Plattnerite (Schwerbleierz, *Breithaupt*), and remove all doubt from that species.

The specific gravity of this specimen is lower than that given by Breithaupt, which is 9·39 – 9·45. The sp. gravity of artificial PbO_2, variously prepared, is given by Herepath, 1824, *Phil. Mag.* lxiv., as 8·902; by Karsten, 1832, *Schweigger's Journ.*, lxv., as 8·988; by Playfair and Joule, 1849, *Journ. Chem. Soc.* 1, from 8·756 to 8·897; and by Werwicke, 1870, *Pogg. Annalen*, cxli., as 9·045; PbO_2, H_2O, given by the same author as having sp. gravity 6·267.

Digitized by Google

On a New Variety of Mineral from Cornwall.

By Prof. E. Kinch, F.C.S., F.I.C., and F. H. Butler, M.A., A.R.S.M.

With a Note on the Crystallographical Characters.

By H. A. Miers, M.A., &c.

[Read June 22nd, 1886.]

SOME two years since the authors received from East Cornwall examples of a crystallised mineral presenting features dissimilar to those of any species previously known to them, but presumably referable to Dufrenite. The specimens obtained were from the central part of a narrow neck of "dead ground" (compact ferruginous quartz rock) connecting the much broader E. and W. continuations of a lode, yielding respectively copper and tin ores.

The freshest crystals have a vitreous lustre, and vary in colour from almost black to a light apple-green, their sections, however, being of a yellow brown to yellow. Where, as commonly, some superficial chemical change has taken place—seemingly into limonite—the colour is from red to brown or yellowish brown. The crystals are aggregated for the most part to form squarish fasciculi, somewhat like files of bills, which are confusedly grouped together or incipiently stalactitic. From the definitely crystallised groups one may observe a passage into merely scabrous nodules and botryoidal masses on the smooth spherules of apparently ordinary Dufrenite. Where compact the mineral shows in section, not infrequently, a sequence of curved strongly contrasted red and green bands, doubtless the result of interstitial change along lines of accretion.

The unaltered (green) crystals have a hardness of about 4·5, and a specific gravity, in the powdered condition, of 3·233. Their qualitative analysis revealed the presence of ferric oxide, phosphoric anhydride, water, minute siliceous granules (gangue), a little CuO and CaO, and a slight trace of MgO, but no FeO or MnO. Neither uranium nor vanadium was detectible, and Al_2O_3 was absent except in the matrix. On ignition the crystals become red, and before the blowpipe they melt without much difficulty.

Quantitative analysis yields the following results:—

Water. No loss *in vacuo* over sulphuric acid. Loss at 100° C. traces only, 1·1502 grs. yielding ·0012 after some hours. By ignition

1·1485	lost ·1228	= 10·69	per cent.	Mean 10·62 per cent. H_2O
1·0073	,, ·107	= 10·62	,,	
·9016	,, ·095	= 10·54	,,	

Digitized by Google

Silica (Quartz sand, none combined) :—

1·1485 gave ·0056 =	·48 per cent.	Mean	SiO_2
1·0078 ,, ·0058 =	·57 ,,	·58 per cent.	
·9016 ,, ·005 =	·55 ,,		

CuO :—

1·1485 gave ·0102 =	·89 per cent.	Mean	CuO
1·0078 ,, ·0112 =	1·11 ,,	·95 per cent.	
·9016 ,, ·0078 =	·86 ,,		

P_2O_5 :—

·4594 gave ·217 $Mg_2P_2O_7$	= 30·21 per cent. P_2O_5	Mean	P_2O_5
·4029 ,, ·1922 ,,	= 30·51 ,, ,,	30·26 p. cent.	
·9016 ,, ·424 ,,	= 30·08 ,, ,,		

Fe_2O_3 (Dry method) :—

1·1485 gave phosphate pp. ·9794	= 85·28 per cent.	Mean	
1·0078 ,, ,, ,, ·866	= 85·97 ,,	85·40 per cent.	
·9016 ,, ,, ,, ·779	= 84·96 ,,		

whence by difference 55·14 per cent. Fe_2O_3.

Volumetrically (1 cc. $K_2Mn_2O_8$ solution = ·00785 Fe_2O_3) :—

·2297 = 16·5 cc. =	56·88 per cent.	Mean	F_2O_3
·2014 = 14·2 cc. =	55·35 ,,	55·63 per cent.	
·889 = 59·1 cc. =	55·28 ,,		
·5944 = 42·4 cc. =	56·16 ,,		

CaO :—

1·0078 gave ·016 CaO	= 1·59 per cent.	Mean	CaO
·9016 ,, ·0227 $CaCO_3$	= 1·41 ,,	1·50 per cent.	

Collecting the above results we have :—

H_2O	= 10·62
SiO_2	= ·53
CuO	= ·95
P_2O_5	= 30·26
Fe_2O_3	= 55·63
CaO	= 1·50
MgO	= traces
	99·49

Eliminating the ·53 per cent. of SiO_2 we obtain the following proportions :—

				Oxygen.
H_2O	= 10·68	...	...	9·49
CuO	= ·96	...	...	·19
P_2O_5	= 30·42	...	...	17·14
Fe_2O_3	= 55·93	...	...	16·78
CaO	= 1·51	...	...	·43
	99·50			

Digitized by Google

Calculated as Fe_2O_3 the CaO and CuO give respectively the numbers 1·44 and ·65 = 2·09. Correcting for the amount ·38 lost by conversion of CaO and CuO, we get finally the percentages:—

H_2O	= 10·72
P_2O_5	= 30·54
Fe_2O_3	= 58·24
	99·50

These numbers lead to the formula

$8\ H_2O$	= 10·51
$3\ P_2O_5$	= 31·09
$5\ Fe_2O_3$	= 58·40
	100·00

Three principal formulæ have been applied or are applicable to minerals under the name of Dufrenite, viz.:—

(1)		(2)		(3)	
	per cent.		per cent.		per cent.
$2\ Fe_2O_3$	= 62·0	$3\ Fe_2O_3$	= 56·21	$5\ Fe_2O_3$	= 58·40
P_2O_5	= 27·5	$2\ P_2O_5$	= 33·25	$3\ P_2O_5$	= 31·09
$3\ H_2O$	= 10·5	$5\ H_2O$	= 10·54	$8\ H_2O$	= 10·51
Oxygen ratio	6 : 5 : 3		9 : 10 : 5		15 : 15 : 8

[Or the last with 7½ molecules of water = Fe_2O_3 58·78, P_2O_5 31·3, H_2O 9·92 = 2 : 2 : 1.]

The first of these is adopted by Maskelyne[1], Church[2] and others, and agrees with the analyses of Karsten[3] and Diesterweg[4] of the dark green mineral from near Siegen, and those of some others.

Our results point, undoubtedly, to the third formula, and this is supported, at all events so far as the ratio of base to acid is concerned, by analyses of Streng, Boricky, and others, though most of these show rather less water than in our Cornish specimens, and always included ferrous oxide.

Apart from chemical considerations, from the description given by Streng[5] of the physical characters of crystallised Kraurite (Dufrenite), from Waldgirmes, near Giessen, there can be little hesitation in concluding

[1] *Journ. Chem. Soc.* 1875 [2]. XIII. 586.
[2] *Chem. News*, 1864, X. 157.
[3] *Arch. f. Bergb. u. Hütt.* XV. 243.
[4] *Berg. u. Hütt. Zeitung*, XXII. 257.
[5] *Neues Jahrb. f. Min.* 1881 (1), p. 101.

Digitized by Google

that it is identical with the mineral now under consideration. Streng's analytical results, however,—

Fe_2O_3	= 60·20	= ·376	= 3·35 or 5·0 or 3·00.
FeO	= 1·53	= ·021	= 0·02
P_2O_5	= 31·82	= ·224	= 2·00 or 3·0 or 1·78.
H_2O	= 8·03	= ·446	= 4·00 or 6·0 or 3·50.
	101·58		

answering to the formula 5 Fe_2O_3, 3 P_2O_5, 6 H_2O, differ from the authors' in the presence of FeO and the absence of CaO and CuO, in containing less water by 2½ per cent., and in being, moreover, too high by over 1½ per cent.; Boricky's[1] analyses of Dufrenite (Kraurite) from St. Benigna, Bohemia, giving—

Dark-green variety.	Per cent.		Light-green variety.	Per cent.	
P_2O_5	= 30·05	= 1·7 or 2·0	P_2O_5	= 32·09	= 1·87 or 2·0
Fe_2O_3	= 59·82	= 3·0 or 3·6	Fe_2O_3	= 57·93	= 3·0 or 3·2
H_2O	= 9·33	= 4·1 or 5·0	H_2O	= 9·04	= 4·1 or 4·8
FeO & Mn_2O_3	= traces.		FeO & Mn_2O_3	= traces.	
	99·2			99·06	

and C. A. Kurlbaum's[2] of radiated Dufrenite from Allentown, New Jersey,

	Per cent.
SiO_2	= 0·72
Fe_2O_3	= 53·74
FeO	= 3·77
P_2O_5	= 32·61
H_2O	= 10·49
	100·95 (*sic*, but = 101·33)

more closely resemble those obtained for the Cornish crystallised mineral in question. It would appear, in fact, that Kurlbaum's specimens contained some Vivianite, probably as a result of commencing chemical change. Calculating all the iron oxide as Fe_2O_3 = 57·51 per cent. he deduces the formula:

3 Fe_2O_3	2 P_2O_5	4 H_2O
57·31 per cent.	34·10 per cent.	8·59 per cent.
but 3 Fe_2O_3	2 P_2O_5	5 H_2O
56·21 ,,	33·25 ,,	10·54 { per cent. seems more probable.

[1] *Bericht. Ak. Wien.*, 1867, LVI. 6.

[2] *Silliman's Am. J. of Science*, 1857 [2], XXIII. 423.

Digitized by Google

Another American specimen from Rockbridge County, Virginia, occurring in nodular masses with a radiated structure, being made up of slender prisms closely compacted, of a very dark blackish green colour and greyish green streak, has been analysed by F. A. Massie[1] and by L. Campbell[2] with almost identical results. The former found H_2O 8·35, SiO_2 ·20, P_2O_5 31·66, Fe_2O_3 50·89, FeO 6·06, Al_2O_3 ·29, MnO ·24, MgO 2·16.

It may be noted here that the percentage of water given for Dufrenite by Church, 10·5 per cent. is almost exactly the same as that found by the authors of the present paper. Maskelyne's formula requires this percentage of water, but a lower proportion of P_2O_5 and a higher proportion of Fe_2O_3 than in the mineral now in question. The identity of the two seems therefore far from clear.

Further chemical examination of pure examples of the ordinary Cornish Dufrenite is perhaps desirable, and one of us is now at work on this.

The crystallised phosphate just described is the only Dufrenite (?) in which copper has been noted, though the occurrence of Dufrenite with Chalcosiderite and its resemblance to that mineral have been noticed. The latter mineral contains over 8 per cent. of copper, and a higher percentage, 15, of water, and also about 4½ per cent. of alumina, but there is a similarity between our formula for the mineral forming the subject of this paper and Maskelyne's (*loc. cit.*) for Chalcosiderite, 8 Fe_2O_3, CuO, 2 P_2O_5, 8 H_2O, the oxygen ratio of base to acid being the same in each case, 1 : 1.

Also the evidence of certain specimens in the possession of the authors points pretty conclusively to the occasional origin of brilliantly crystallised Chalcosiderite in the decomposition of this phosphate—presumably by the infiltration of a solution of some copper salt, and replacement thereby of an equivalent amount of ferric oxide by copper oxide, with simultaneous addition of water.

From Maskelyne's Andrewsite the crystals under consideration differ in composition chiefly in the absence of ferrous oxide, and in containing less than a tenth as much cupric oxide.

We submit that there is evidence that this mineral (as well as others described under the head Dufrenite) contains a larger proportion of phosphoric acid to base than is compatible with the usual formula given for Dufrenite, 2 Fe_2O_3, P_2O_5, 8 H_2O; and that (unless it should be afterwards shown that some of the earlier analysed specimens contained iron oxides

[1] *Chemical News*, 1880, XLII. 181.

[2] *Amer. J. Science*, 1881 [3], XXII. 65.

Digitized by Google

as impurities) the species must be divided into two, one having the formula 5 Fe_2O_3, 8 P_2O_5, 8 H_2O (or possibly in some cases less water).

Having regard to the conclusions we have so far arrived at, it is not our intention to propose a new name for this mineral.'

Note by H. A. MIERS.

THE crystals occur in the form of rectangular tables about 1 to 2 mm. in length and breadth, and ¼ to ½ mm. in thickness; they may be regarded in all probability as orthorhombic plates formed by the macropinakoid faces {010}, bevilled at the sides by small faces of the prism {110}, and bounded at top and bottom by the basal planes {001}, the latter, however, sometimes rounded into a low brachydome. The best measurements gave an angle of 86°26′ for the prism, and 12°45′ for the inclination of the flat dome to the basal plane; but the crystals are so invariably grouped into penetrating bundles that it is almost impossible to find one which can be regarded as strictly a single individual, consequently neither the system nor the dimensions could be determined with certainty. The groups are generally sheaf-like aggregates, in which the plates radiate from a central axis and have their basal planes nearly parallel; the crystals are also frequently heaped together into confused rounded masses, in which the basal planes all lie outwards, and these again pass into smooth spherical and botryoidal concretions of radial structure. Sections parallel to the macropinakoid show marked dichroism, and between crossed nicols extinguish parallel and perpendicular to the prism edges. The crystallographic characters agree closely with those of Dufrenite from Waldgirmes, near Giessen, described by A. Streng (*Op. cit.* p. 110), and the habit is nearly that of fig. 7 in the plate accompanying his description.

Digitized by Google

Cassiterite of the Straits Settlements.

By J. H. Hampton.

[Read October 26th, 1886.]

THE tin from the Straits Settlements has hitherto been solely derived from the alluvial deposits, and is consequently in the form of alluvial or "stream" tin—each grain of Cassiterite being separate, and in many cases so considerably water-worn as to afford evidence of its having been washed down for a considerable distance; the angles of the grains having given place to smooth surfaces during their deposition.

The largest grains occur on the tops of some of the hills, with a diminution in size noticeable with distance from the hills.

The mineral is contained in beds of pebble-shaped quartz and granite, which denote the Cassiterite-producing "Wash"; these vary in thickness from a few inches to several feet, and contain from ¼ to 80 per cent. of the mineral. The wash rests on a bed of kaolin, or on the bed rock, which is granite, syenite, or limestone, the crevices in which are often found to hold a high percentage of the mineral. More Tourmaline is noticeable in these deposits than I have seen in Cornwall or Tasmania, and as other impurities are rare, the Cassiterite is easily separated from minerals of less specific gravity and prepared for smelting. Pyrites is occasionally found, but its existence is an exception to the rule.

Cassiterite has a wide range in the Malay Peninsula, and is visible in some places on the surface of the ground and at depths ranging to sixty feet.

White Cassiterite is of frequent occurrence, and occasionally I have seen specimens of "ruby ore," and imperfect crystals with one or two planes uninjured; these appear to have become fractured at some remote period, as in most cases the fractures are water-worn.

Individual specimens of the mineral are found which suggest the possibility of its being traced to its original matrix.

Digitized by Google

On the Occurrence of considerable Deposits of Limonite (Bog Iron Ore) in North-west Ross-shire.

By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read October 26th, 1886.]

DURING the course of an inquiry into the nature and extent of the less known iron ore deposits of Scotland undertaken in connection with a paper to be communicated to the Society of Antiquaries of Scotland during the Winter Session 1886-87, I have been led to consider certain masses of Bog Iron Ore which are distributed somewhat widely over the less cultivated portions of the country. The present communication deals only with the north-westerly portion of Ross-shire, and most of the localities are within the parish of Gairloch.

1. *Cove.*—A small township some seven miles north-west of Poolewe. The deposit is not of great extent, and now occupies a raised position, the harder iron oxide having resisted the action of the elements more successfully than the loose sandy soil by which it was surrounded.

2. *Inverasdale.*—A township about four miles north-west of Poolewe. The locality contains very considerable deposits of the mineral. During the short stay we made four somewhat large "pans" were discovered, and from the fact that masses of the substance were found used as building stones in the drystone dykes in the neighbourhood there are doubtless many more deposits in the locality. At the time of my visit the crofters' patches were under oats, which hindered proper investigation. The principal deposit was found directly opposite the schoolhouse, and two others to the seaward of the same building, with a less deposit to the south of the school.

3. *Laid School.*—On the road, in a cutting directly above Laid School, a small deposit of poor ore occurs.

4. *Laid Churchyard.*—Loch Gruinard. The deposit occurs on ground now enclosed as a cemetery. The extreme hardness of the mass has saved it from being broken up. The deposit is about six inches thick and covers a considerable area.

5. *North Erradale.*—About six miles north-west of Gairloch village and half-a-mile from the sea. The deposit is not great.

6. *Little Sand.*—On the shore of the Gairloch, and about 8½ miles

Digitized by Google

north-west of the village of Gairloch. The deposit is about 50 feet above the shore line.

7. *Lonmor.*—About a mile and a half nearer Gairloch village than the preceding deposit. The substance is about 150 feet above sea-level.

8. *Strath of Gairloch.*—About 2 miles north of Gairloch village, and about 150 feet above sea-level.

9. *South Erradale.*—This township lies to the south-west of Gairloch. It occupies a flat strath formed by the Abhuiun Ruadh or "red burn." The extent of this deposit is enormous, covering acres of land. It averages from 9 to 18 inches thick, and has been utilised by the inhabitants for building the walls forming the boundaries of the township. One large "dyke" is called the "iron dyke," and is wholly composed of the Bog Ore. There must be some hundreds of yards of these "iron dykes." The material is still being formed, and the locality is certainly one of the most rich in the country for this particular iron ore.

10. *Point of Gairloch*, or the "Red Point." About 3 miles further south than the preceding a deposit has been found of considerable depth and extent.

Several of the samples taken from these localities have been tested for iron, and the results obtained are as follows:—

Bog Iron Ores from Gairloch Parish, North-west Ross-shire.

		Ferric Oxide.	*Equal to Metallic Iron.*	*Silica.*
1. Cove ...	(*a*)	72·54	50·77	3·56
	(*b*)	5·48	3·83	85·92
5. North Erradale	(*a*)	69·84	48·88	2·61
	(*b*)	55·42	38·79	12·64
6. Little Sand...		73·68	51·57	4·72
7. Lonmor ...		73·16	51·21	3·84
8. Strath of Gairloch		30·48	21·33	60·56
9. South Erradale	(*a*)	70·88	49·61	7·48
	(*b*)	66·68	46·67	8·24
10. Point Gairloch	(*a*)	71·04	49·72	10·61
	(*b*)	20·84	14·58	61·08

Digitized by Google

Further Note on Agalmatolite in Gairloch Parish, Ross-shire.

By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read October 26th, 1886.]

In my previous communication* I drew attention to an impure variety of Agalmatolite found on Creag Mhôr Thollie, and which contained an excess of silica. A similar body was referred to in connection with Mr. Hamilton Bell's paper on "New Localities for Agalmatolite"† as having been obtained from Ballater Pass. In connection with the material obtained at Creag Mhôr Thollie, I expressed the opinion that the agalmatolitic mineral had been formed in the presence of an excess of silica which had become combined with the other ingredients, forming what I then termed a "Siliceous Agalmatolite."

During the past summer I have again had an opportunity of examining the Creag, and towards the northmost end found very large masses of the pure mineral. The colour of the substance is the usual pea-green tint, greasy to touch, soft to the knife, and fracture conchoidal. The quantity present is large, and the various transition appearances are readily observed. It much resembles the Kean na Binn and Lua Yayi samples. It is frequently found to pass into less pure varieties, resembling the material referred to on page 29. The chemical analysis gave:—

	Agalmatolite. *Creag Mhôr Thollie, Ross-shire.*
Silica	50·362
Alumina	32·015
Ferric Oxide	2·207
Magnesic ,, ...	0·528
Calcic ,, ...	0·086
Potassic ,, ...	7·833
Sodic ,, ...	0·121
Water	6·742
	99·889

* Vol. VII. p. 29.

† Vol. VII. p. 28.

Digitized by Google

On the Analysis of a Sample of Talc used in Paper-making.

By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read October 26th, 1886.]

THE mineral to which this notice refers is obtained from New Jersey. It is very largely employed for paper-making in place of China clay (Kaolin), and gives, amongst other advantages, a much more pure effluent, fully ninety per cent. being retained in the paper. From its fibrous nature it appears to attach itself to the smaller paper particles and retain these also. The very high and beautifully smooth glaze of the American papers is largely due to the use of this substance.

The mineral is of a highly fibrous character, almost pure white, perfectly insoluble in water, is greasy to the touch, and readily broken down in the fingers. Its specific gravity ranges from 2·22 to 2·562 (water 1·000). Commercial name *Agalite*.

Analysis.

Silica	62·077
Magnesic Oxide	33·126
Ferrous Oxide	0·104
Aluminic Oxide	0·313
Water of Hydration	4·286
Loss and Undetermined	0·094
	100·000

Digitized by Google

Analyses of Samples of China Clay (Kaolinite), Cornwall.

By W. Ivison Macadam, F.I.C., F.C.S., Professor of Chemistry, New Veterinary College, Edinburgh.

[Read October 26th, 1886.]

No.	*Silica.*	*Aluminic Oxide.*	*Ferric Oxide.*	*Calcic Oxide.*	*Magnesic Oxide.*	*Potassic and Sodic Oxides, &c.*	*Moisture.*
1	61·02	28·64	1·96	2·36	0·45	1·76	3·81
2	64·75	21·24	3·64	2·71	0·32	0·92	6·42
3	62·62	27·48	2·14	2·22	0·44	1·54	3·56
4	56·96	29·82	4·96	2·56	0·59	1·48	3·63
5	56·86	28·24	5·72	2·63	0·81	1·46	4·28
6	61·47	26·12	3·48	2·46	0·72	1·32	4·43
7	75·91	10·63	5·32	2·45	0·71	0·64	4·34
8	44·18	34·43	0·42	1·86	0·52	1·68	16·91
9	44·82	35·61	0·48	1·92	0·61	1·52	15·04
10	43·62	35·12	0·47	1·89	0·54	1·94	16·42
11	49·65	45·24	0·34	1·53	0·52	0·78	1·96
12	50·12	39·16	0·43	2·16	0·89	2·32	4·92
13	49·24	39·84	0·57	2·34	0·93	2·47	4·61
14	47·43	39·42	0·28	0·92	0·33	2·31	9·31
15	50·81	38·12	0·24	0·89	0·31	2·42	7·71
16	51·55	34·17	0·28	1·13	0·38	1·97	10·52
17	49·12	36·94	0·26	0·83	0·27	2·08	10·50
18	50·29	36·17	0·25	0·85	0·29	1·82	10·33
19	47·65	36·18	0·26	0·82	0·29	2·06	12·74
20	67·92	22·52	0·31	1·58	0·51	0·44	6·72
21	66·96	23·56	0·37	0·84	0·41	0·70	7·16
22	76·04	13·76	0·22	1·06	0·39	2·05	6·48
23	69·60	22·44	0·21	0·96	0·42	1·69	4·68
24	59·88	26·68	0·24	0·71	0·34	7·43	4·72
25	48·24	38·83	0·34	0·74	0·29	6·40	5·16
26	65·52	25·12	0·24	0·71	0·28	2·95	5·18
27	66·36	24·32	0·31	0·68	0·27	3·18	4·88

Specific Gravity from 2·4 to 2·6 (Water 1·000).

Digitized by Google

Note on the Identification of the Scotch and New Brunswick "Albertites."

By the Rev. D. Honeyman, D.C.L., F.R.S.C., Curator of the Provincial Museum, Halifax, Nova Scotia.

(Communicated by Professor W. Ivison Macadam.)

[Read October 26th, 1886.]

PROF. TENNANT, of London, and I, identified the two "Albertites" in 1862. I was then a Commissioner for Nova Scotia at the Great Exhibition. In the neighbouring Court of New Brunswick there was a tub full of specimens of Albertite, which were freely given to visitors by Mr. Daniel, the Commissioner for New Brunswick, and myself.

It was, therefore, no astonishment when the Professor's assistant put into my hand a piece of "Albertite" as I entered the shop, and asked me what I thought of it. I said, "It is a piece of our New Brunswick Albertite." He replied, it was not from New Brunswick, but from some part of England, and showed me a boxfull that had just been received. The only guide to the locality whence it came were the markings on the lid of the box—"Aberdeen Railway" and Kiltearn. A Scotchman could recognise Scotland in "Earn." On referring to Murchison and Geikie's map, I soon found Kiltearn, and observed that the Old Red Sandstone was the formation that produced the mineral. One of the specimens had a piece of micaceous rock attached. The Professor told me that he had received the box from a Mr. Mackenzie. We made a comparative examination of the two Albertites. The result was communicated to Mr. Mackenzie, with a copy of Dawson's paper on the New Brunswick Albertite, contained in the *Quarterly Journal of the Geological Society of London.* At the Geologist's Club I showed the piece with the rock attached to Prof. (Sir) Andrew Ramsay. He immediately said that it was a piece of our *Nova Scotia* Albertite, but was somewhat astonished when I told him it was from Kiltearn, Scotland. I gave him the specimen. He said he would put it in the Museum. Another of those pieces is preserved in our Provincial Museum, where it lies beside a New Brunswick specimen for the purpose of comparison. The only difference observable between the two is in the shade of colour. The Scotch specimen is blacker than the other.

It is not generally known that the New Brunswick mineral was first brought into notice by Dr. Abraham Gerner, F.G.S., the pioneer geologist of Nova Scotia and New Brunswick. He maintained that it was an

Digitized by Google

asphalt and not a coal, and applied it as the former to the manufacture of gas, in opposition to a monopoly of making gas from coal. There was a litigation and a diversity of opinion in reference to the nature of the substance. It consequently received the name Albertite, from Albert County, New Brunswick, where it is found.

After doing good service in the manufacture of gas in New Brunswick, Nova Scotia, and elsewhere, for a number of years, the deposit was exhausted. Another locality called Belleveau was operated for Albertite without success. Prof. Burwash, *Trans. Institute of Nat. Science*, Vol. IV. p. 309.

The bituminous shales containing the Albertite have produced a large number of ganoids, large and small, chiefly of the genus *Palæoniscus*. This and Belleveau are the only localities where we find fishes entire in the carboniferous formation of Nova Scotia and New Brunswick. The bituminous shales of Antigonish County have abundance of scales of *Palæoniscus*. In corresponding shales of Horton Bluff, also in Nova Scotia, I have collected *Palæoniscus* scales and teeth, separate, and in a lower jaw. Various Lepidodendra have been found associated in the Antigonish shales.

Albertite is thus found in the Lower Carboniferous formation in New Brunswick, and the Old Red Sandstone of Kiltearn (Strathpeffer). How it was inserted in the one and the other yet requires to be demonstrated.

Digitized by Google

Note on Schorlaceous Rocks from near St. Austell.

By F. H. Butler, M.A., A.R.S.M.

[Read October 26th, 1886.]

CERTAIN specimens of rock lately obtained by me from the "Single Rose" Clay Work, near St. Austell, Cornwall, examples of which are now submitted to the Society, illustrate well the processes by which, in some instances at least, granite has been transformed into an aggregate of quartz and schorl.

A comparison of the chemical composition of orthoclase from Roche with that of kaolin from the neighbouring district of St. Stephen's shows that in the passage of felspar into China clay there is approximately a loss of 26 per cent. SiO_2 and a gain of 19 per cent. Al_2O_3 and 12 per cent. H_2O. In the St. Austell district, the evolution of Gilbertite would appear to be one of the possible stages in the gradual disintegration and disappearance of granitic felspar: both its chemical composition and its mode of occurrence point to this conclusion.

Orthoclase. Glass Mine, Roche (Phillips).		Gilbertite. Stenna Gwynn (Lehunt).		Kaolin. St. Stephen's (Boase).	
SiO_2 ...	65·00	SiO_2 ...	45·15	SiO_2 ...	39·55
Al_2O_3 ...	19·00	Al_2O_3 ...	40·11	Al_2O_3 ...	38·05
Fe_2O_3 ...	·50	FeO ...	2·43	MgO ...	1·45
CaO ...	1·57	MgO ...	1·90	K_2O & loss	8·70
MgO ...	trace.	CaO ..	4·17	H_2O ...	12·30
K_2O ...	10·37	H_2O ...	4·25		
Na_2O ...	2·40		98·01		100·05
H_2O ...	·88				
	99·67				

In this district the kaolinisation of the granite has, moreover, as perceptible in the specimens exhibited, been frequently associated with the production of schorl. This mineral has by degrees more or less completely pervaded the rock-mass, crystallising out in the minute cavities formed in it during the removal of constituents.

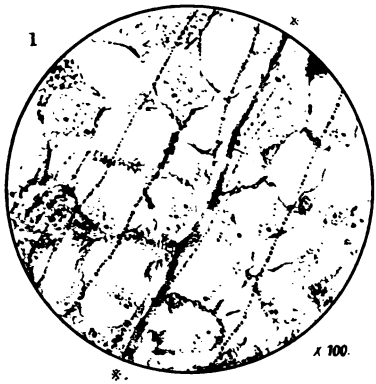
A synchronous and perhaps also slightly precursory stage of alteration is shown in the black highly schorlaceous rock in which the kaolin, with the exception of traces, has been removed from the cavities originally

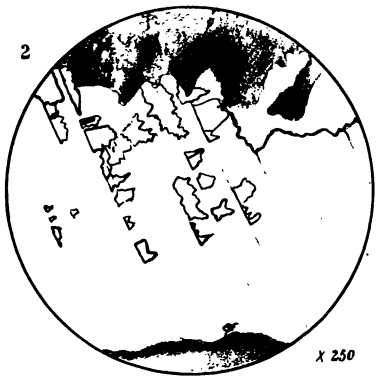
Digitized by Google

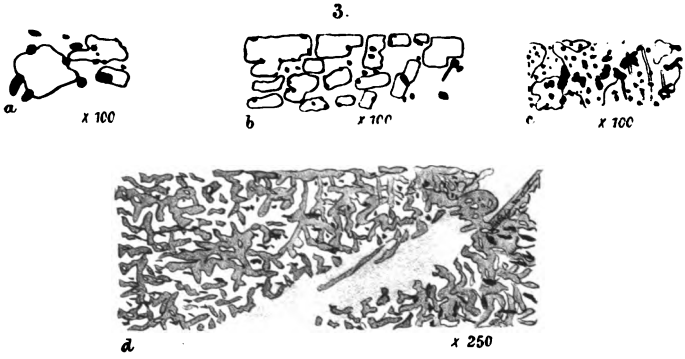
occupied by crystals of orthoclase, and these have been filled with somewhat loosely cemented crystalline granules of quartz. The silicification of the rock, as the employment of a lens proves, must certainly have set in previous to the period of the full development of the schorl; for this latter mineral may be seen to have penetrated but little into the pseudomorphous quartz casts, and also to have formed a pretty well-defined line of demarcation about the same. It is, of course, open to conjecture whether the quartz is in part represented by silica once entering into the composition of the felspar that has disappeared.

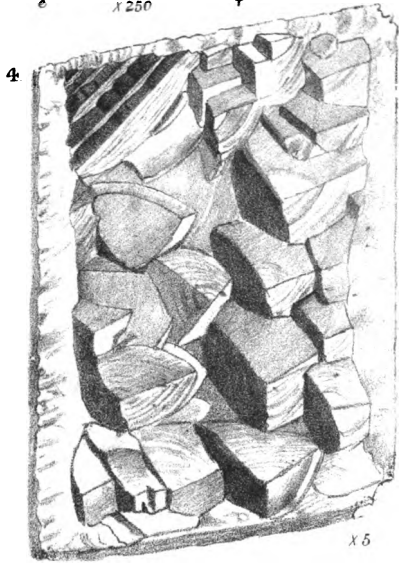
Digitized by Google

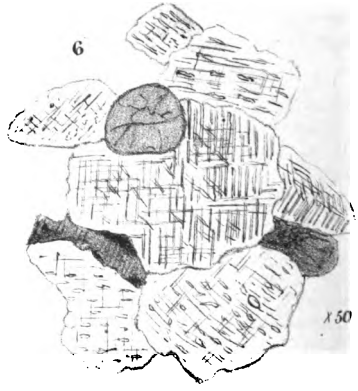
Digitized by Google











iel et lith.

Mintern Bros. imp.

Illustrations of Schillerization.

Digitized by Google

On the Relations between the Solution-planes of Crystals and those of Secondary Twinning; and on the Mode of Development of Negative Crystals along the former. A Contribution to the Theory of Schillerization.

By Prof. JOHN W. JUDD, F.R.S., P.G.S.

PLATE III.

IN the case of many common rock-forming minerals—the felspars, the pyroxenes, the olivines and the micas—it has been shown that the crystals which have existed in rock-masses at great depths exhibit constant and characteristic differences from the crystals of the same mineral, in rocks of identical composition, which have been formed at the surface. It has been proved, moreover, that these differences become more and more pronounced in proportion to the distance from the surface at which these rocks have originally existed.*

Although some of these peculiarities of the crystals of deep-seated rock-masses can be satisfactorily accounted for by the conditions of pressure and slow growth under which they were originally formed, yet there are others—and these by no means the least striking of them, such as the continuous bands of fluid-enclosures, the avanturine structure and schiller, and the chatoyant phenomena—which are clearly not original, but are due to secondary actions. This is proved by the fact that such structures are in many cases not distributed uniformly through the whole of the crystals, but are developed from their exterior or along lines of accidental fissures which traverse them.† In such instances it is clear that the formation of the cracks must be posterior to that of the crystals which they traverse; and that the development of a structure which is determined by these lines of crack must be of later date still.‡

---

* *Quart. Journ. Geol. Soc.* Vol XLI. (1885), pp. 374–389.

† *Loc. cit.* Plates X. to XII. with description.

‡ Mr. G. H. Williams, in his very interesting paper on "The Peridotites of the Cortlandt Series," in the *American Journal of Science* for January 1886, has written under some misapprehension of the arguments of my paper. That certain enclosures in minerals are original and were formed during the growth of the crystals, I have never denied. My arguments were intended to apply to the cases of those enclosures which I have proved, by the most conclusive evidence, to be of *secondary* origin. When we find structures developed having unmistakeable relations with the accidental fissures of a crystal, it is as impossible to deny their secondary origin as it is to doubt that the serpentine found bounding the accidental cracks in a crystal of olivine was formed long subsequently to the crystallisation of the olivine itself.

Digitized by Google

From the study of all the facts exhibited in these interesting cases, I have been led to propose a theory of Schillerization which is based on certain postulates. These postulates are as follows :—

First.—If a crystal be subjected to intense strain, planes of easy solubility arise parallel to the directions along which the strain is exerted, and, in consequence of this, cavities, filled with liquids or solids, the product of the solvent action, will be formed along such planes.

Second.—In every crystal, in addition to the planes of least cohesion (cleavage-planes), and the planes along which slipping accompanied by a rotation of certain of the molecules occurs (gliding-planes), there is a third set of "structure-planes," those, namely, along which chemical action takes place most easily. These planes of chemical weakness, like the cleavage-planes and the gliding-planes, have definite relations with the symmetry of the particular system to which the crystal belongs.

Third.—Along these planes of chemical weakness, the solvent agencies working under great pressure operate in such a way as to produce cavities, which frequently take the form of negative crystals; and these may become more or less completely filled with secondary products. As solvent power is augmented by pressure, and pressure increases with the distance from the surface at which the crystal exists, the plane of greatest chemical weakness is first attacked at a certain depth, and at successively greater depths the other less pronounced planes of chemical weakness will be found to be in turn affected.

Fourth.—Although the planes of cleavage, of gliding, and of susceptibility to chemical action in a crystal are all distinct from one another, yet in most, if not in all crystals, there appear to be certain curious and very interesting relations between them.

Although I have long felt that it is impossible to account for the characteristics presented by the minerals of deep-seated rock-masses without assuming the truth of the above postulates, it is evidently most desirable to obtain experimental verifications of them. But inasmuch as our command of great pressures, and especially as our means of submitting crystals to weak chemical actions during enormous periods of time is very limited, the difficulties in the way of obtaining such experimental verifications seemed to me to be very great, if not, indeed, actually insuperable. I hope to show, however, in the present paper that very convincing evidence of the truth of all these postulates can really be adduced.

I. With respect to the production of cavities, filled with liquids or with solid decomposition products, along bands of strain, I have succeeded

Digitized by Google

in obtaining a very striking confirmation of the truth of the principle laid down. Near the gigantic fault which bounds the southern edge of the Scottish Highlands, the quartzite-pebbles of the Old-Red-Sandstone Conglomerate are found exhibiting striking evidence of the tremendous mechanical forces to which they have been subjected; sometimes one pebble is found deeply impressing another, and not unfrequently the whole of the pebbles are found to be crushed to fragments, which have been re-cemented by the deposition of secondary quartz or of calcite. In the case of a quartzite pebble which has been faulted—the mass yielding at last to the tremendous stress upon it—it occurred to me that before the pebble gave way to the force operating upon it, it must have been in a state of prolonged and violent strain along planes parallel to that in which it eventually yielded. Such being the case, if the principle which I have announced be true, we ought to find cavities filled with liquid and solid materials formed in planes parallel with that in which faulting eventually took place.

On making thin sections across such faulted pebbles, I found my anticipations to be fully realised (see Plate III. fig. 1). The quartzite is seen under the microscope to be made up of sand-grains which are portions of quartz crystals, these being cemented by secondary quartz deposited in crystallographic continuity with them, in accordance with the principle so well illustrated by Tornebŏhm, Sorby and Bonney. These crystalline fragments lie in every possible position, as is shown when they are viewed by polarised light, and they contain the acicular crystals of rutile and other minerals with the original liquid-cavities which distinguished the quartz of the rock from which they were derived. But running through all the grains, quite irrespectively of their orientation, we see under the microscope a series of dark lines, straight as if ruled, and showing an unmistakeable parallelism with the plane along which faulting has taken place (* * in the figure). By the use of higher powers of the microscope these dark lines are resolved into bands of cavities containing liquids or with secondary infillings of solid matter. It is impossible to doubt that these bands of cavities with their fluid and solid inclusions have been produced by solvent action along the bands of strain.

II. With respect to the proposition which postulates the existence of definite planes of chemical weakness in crystals, it is manifestly difficult to obtain experimental verification in the case of the ordinary compound silicates with which the geologist has ordinarily to deal. It is probable that under the enormous pressures which exist at great depths in the earth's crust, the whole substance of such crystals is permeated by fluid and

Digitized by Google

gaseous materials capable of exercising a chemical action on the materials through which they pass. Even the methods employed with so much success by M. Daubrée could scarcely enable us to imitate the effects produced under such conditions as these. But in the case of crystals of calcite, aragonite and other minerals affected by weak solvents, it appeared to me not impossible to obtain experimental evidence of the existence of planes of chemical weakness, such as I have argued must exist in the case of the rock-forming silicates.

I had been for some time experimenting on calcite with this end in view, and not without successful results, when I found that the whole question had been dealt with in a very masterly manner by Professor Von Ebner of Gratz.*

Professor Von Ebner was led to the examination of this question from a totally different starting-point to my own. The appearances presented by certain spiculæ of calcareous sponges induced him to investigate the action of various weak solvents upon minute cleavage-fragments of calcite. A discussion of all the phenomena led him to the conclusion that there are certain planes of easy solubility which he compared to planes of least cohesion (cleavage-planes), and for these he proposes the name of solution-planes (*Lösungsflächen*). From a discussion of a great number of careful experiments he arrives at the conclusion that the primary solution-planes of calcite are parallel to $-2R$. $(\bar{1}11.)$

The very complicated phenomena of the etching figures produced on the faces and the different cleavage-planes of crystals by the action of solvents have been investigated by many observers. Since the time of Daniell, who first called attention to their importance in 1816, Leydolt, Baumhauer, Klocke, Becke and many other crystallographers have obtained a number of very valuable and suggestive results.

Professor Von Ebner discusses the whole series of remarkable forms developed by the action of solvents upon the different faces and the cleavage-planes of calcite crystals. He shows that all the diversified and complicated forms thus produced, with their curved and striated surfaces—which vary with the nature, the degree of concentration, and the temperature of the solvent, and especially with the rate at which the chemical action takes place—are capable of explanation if his view of the existence of

* Die Lösungsflächen des Kalkspathes und des Aragonites. I. Die Lösungsflächen und Lösungsgestalten des Kalkspathes (Sitzber. der Kais. Wiener Akad. der Wissensch. 89 Bd. II. Abth. 1884, pp. 368-458. II. Die Ätzfiguren des Kalkspathes. III. Die Lösungsflächen des Aragonites (Sitzber. der Kais. Wiener. Akad. der Wissensch. Bd. 91. II. Abth. (1885), pp. 760-835.

Digitized by Google

"solution-planes" be true, by the combination of and oscillation between solvent actions along different planes. He not inaptly compares the curious curved and striated figures produced by the action of acids upon calcite, to the "hardness-curves" suggested by Exner as a means of expressing the cohesive force in different parts of a crystal mass as determined by the sclerometer.

The result of Professor Von Ebner's researches is that, so far as calcite and aragonite are concerned, certain planes exist along which chemical action takes place more readily than in other directions within the crystals. It is these which Prof. Von Ebner proposes to call solution-planes (Lösungsflächen); but we must remember that the examples given are not cases of simple solution, the calcic carbonate of the crystals being actually decomposed; the circumstance which is so well illustrated by Von Ebner's experiments, that the results differ with the particular acids employed—acetic acid, formic acid, phosphoric acid or hydrochloric acid—indeed confirm the conclusion that the action ought not to be treated as one of simple solution. Perhaps, however, the name of "solution-planes," if the qualification insisted upon be borne in mind, is the simplest and most convenient that could be employed. I have already fully explained the ground for the conclusion that such solution-planes must exist in the case of many common rock-forming crystals,* and if their existence is regarded as proved in the case of the carbonates there can be no difficulty in accepting it in the case of the silicates.

III. That cavities, often taking the forms of negative crystals, make their appearance along the solution-planes of crystals, I have been able to show by some results obtained accidentally during my experiments with calcite. In Plate III. fig. 2 is represented a case where the acid eating into the calcite mass, along definite planes, has evidently given rise to forms with more or less rectilinear boundaries which clearly approximate in some cases to negative crystals.

But it is by the study of some of the more gigantic secondary enclosures of crystals—like those sometimes found in the labradorite of Labrador, and which impart to it its *avanturine* character—that we obtain the clearest evidence concerning the series of processes by which the negative crystals are eaten-out along the "solution-planes" of the crystal. By studying a series showing such structures in every stage of development, we may demonstrate the whole series of processes by which the negative crystals are formed and become filled with secondary products.

* *Quart. Journ. Geol. Soc.* Vol. XLI. (1885), p. 385.

Digitized by Google

This series of processes appears to be as follows (See Plate III. Fig. 3). :—

First.—In the clear body of the crystal scattered cavities of irregular form make their appearance. These cavities clearly lie in one or more sets of parallel planes traversing the crystal. The cavities have two flat sides, parallel to the planes in which they lie, but their peripheries are often quite irregular. Not unfrequently, however, there is a marked tendency to the assumption of rectilinear outlines, and the cavity may thus gradually pass into a negative crystal. Sometimes these irregular cavities are found more or less completely filled with brown secondary products. (Fig. 3, a, b, c.)

Second.—Not unfrequently these flat-sided and more or less irregular cavities are seen to be developed within a field which has a clear tendency to a form with rectilinear outlines. As the cavities become more and more crowded, thus encroaching upon one another, the field with scattered cavities passes into a large negative crystal. (Fig. 3, b, c, d.)

Its infilling with secondary products may take place at any stage of the development of the negative crystal; the irregular cavities may be partially or completely filled with the decomposition products before they have been made to unite by the continuation of the solvent process, or the whole negative crystal may be completely formed before the deposition of the secondary products takes place. Fig. 3, d, e, f, illustrates these different stages of development of negative cavities and their infilling by the secondary products.

Third.—As the final stage of this kind of action we get the large plates of brown material, presenting forms with rectilinear outlines. These produce the avanturine appearance, and have been frequently mistaken for crystals of foreign minerals caught up and included in the Labradorite crystal during its growth. (See Fig. 3, e, f, g.) Occasionally, as in Fig. 3 g., very characteristic forms of felspar are assumed by these negative crystals; in cases like the one figured, a measurement of the angles, as exactly as is possible with such minute bodies, shows a very close correspondence with the angles characteristic of labradorite.

It is only occasionally that we get the whole series of processes so clearly exemplified as in the example from which the drawings are taken; but no one can inspect such a series without recognising the succession of processes by which the phenomenon of "avanturism" is produced in this particular case.

It will be instructive to compare this method of the formation and infilling of negative crystals in labradorite with that previously described

Digitized by Google

as taking place in the olivines of the Island of Rum.* There is reason to believe that there is a difference in the exact *modus operandi* of the production and infilling of negative crystals in the case, not only of different mineral species, but of the same mineral under different conditions.

IV.—Bearing upon the relations between the several "structure-planes" in a crystal, we have the interesting observations of Mügge,† which seem to indicate the mutual interchangeability of the cleavage-planes and the gliding-planes. That a remarkable relation also exists between the third set of structure planes—the solution-planes—and the gliding-planes seemed to me to be indicated by my study of some of the rock-forming minerals in deep-seated masses.

Thus ordinary specimens of diallage appear to indicate that the first or easiest solution-plane in augite is parallel to the orthopinacoid, while the variety known as pseudo-hypersthene proves that the second and third solution-planes are respectively parallel to the clinopinacoid and the basal pinacoid. But Mügge has shown that augite (diopside) may be made to exhibit artificial twinning along planes parallel to the basal pinacoid.‡ The type of augite crystals first noticed in the Whin-sill by William Phillips, show that when such crystals possess the secondary lamellar twinning parallel to the basal pinacoid, these twin planes become the planes of easiest solubility in preference to the normal solution-planes. In this way we account for the interesting circumstance that the Whin-sill and similar augites exhibit a schiller structure parallel to the basal plane, and not, as in diallage, parallel to the orthopinacoid.§

My experiments with calcite have afforded me a striking proof of the conclusion that the development of secondary lamellar twinning in a crystal leads to these twin-planes becoming the planes of easiest solubility, in preference to the normal solution-planes.

A cleavage-rhomb of calcite, upon one corner of which I produced by pressure a series of twin lamellæ parallel to $-\frac{1}{2}$ R (110), was submitted to the slow action of dilute hydrochloric acid. Over the cleavage surfaces the usual curved and striated planes of the etched figures proper to those planes were produced (See Plate III. Fig. 4).

Where, however, twinning lamellæ had been produced, solvent action very readily took place along the twinning planes. When these twin-

* *Quart. Journ. Geol. Soc.* Vol. XLI. (1885), p. 382. Plate XII. Figs. 4 and 5.

† *Neues Jahrb. für Min.* 1883, I. p. 32.

‡ *Ibid.* 1886. p. 185.

§ *Quart. Journ. Geol. Soc.* Vol. XLI. (1885), p. 379.

Digitized by Google

ning planes were some distance apart, the intermediate zones of calcite showed a tendency to assume the ordinary etched figures; but where they were close together these became obscure or altogether disappeared. Hence we conclude that in a crystal of calcite where fine lamellar twinning has been produced, the twinning-planes $-\frac{1}{2}$ R (110) would be more susceptible to the solvent action than the normal solution-planes, which Von Ebner has shown to be parallel to -2 R ($\bar{1}11$).

It will be necessary, therefore, in the case of each mineral species to determine which of the solution-planes are normal ones and which are secondary ones, resulting from the previous twinning of the crystal by pressure.

I have already pointed out some of the extreme changes which may be produced in the character and appearance of a crystal by the Schillerizing process.

In some cases the development of cavities along certain planes within the crystal goes on to such an extent that the bulk of the skeleton of the crystal which is left may be less than the united bulk of the cavities which have been developed in them. This is very well seen in the plagioclase crystals in the scapolite-rock of Bamle. It is a significant circumstance that the scapolite appears to be formed at the expense of the plagioclase with its liquid cavities, which latter contain, in all probability, various soluble chlorides. MM. Fouqué and Michel-Lévy found that the scapolite and hornblende-rock, when fused, reproduced a rock made up of labradorite and pyroxene.*

I have shown that by the multiplication of minute inclusions coloured by iron oxides the whole of the felspars in a deep seated rock may acquire a brown tint, and be rendered more or less opaque.† In cases of this kind, the relation of the solution-planes to those of pre-existing lamellar-twinning is sometimes very clearly exhibited. Certain gabbros, especially those of granulitic habit, from Scandinavia, Scotland, Saxony and North America, have the minute black enclosures in their plagioclase felspars clearly arranged parallel to the Albite and Pericline twinning-planes.‡ Where either of these planes are seen by the aid of polarised light to be developed in any part of the crystals, there the enclosures appear marking them out, and where the two twin-lamellæ exist in conjunction,

* *Bull. Soc. Min. Fr.* II. (1879), p. 113.

† *Quart. Journ. Geol. Soc.* Vol. XLI. (1885). Pl. X. F. 7, pp. 376, 377.

‡ The crystals of these granulitic rocks often exhibit a peculiarity, for which I do not at present find myself able to suggest any explanation. An irregular outer zone of the rounded crystals appears to be free from the secondary inclusions which are beautifully developed in their central portions. This peculiarity is not exhibited by rocks with a granitic structure.

Digitized by Google

there the double structure is seen to be clearly marked out by the enclosures when the section is examined with high powers. That the twin-lamellæ are of later date than the crystal in which they interruptedly occur, is shown by their relations to the accidental cracks of the crystal. The exact correspondence of the bands of enclosures with the secondary twinning structure, however partially and interruptedly this may occur, shows that the former must have been produced at a later date than the latter. In such cases as these, as I have already shown, the solvent action by which the enclosures were produced, must have taken place while the crystals existed as parts of deep-seated rock-masses.

A very remarkable illustration of the relation between the secondary twinning of a crystal and the enclosures developed in it is exhibited by a crystal of felspar in a "diallage and hypersthene gabbro" from Humlebäk Scharf, Norway, as represented in Plate III., Fig. 5. Here the crystal has been bent, and on examination with polarised light, Albite twinning-planes are seen to be strongly developed in the middle part of the crystal where the flexure has been greatest, but are found to die away towards the ends where there has been no violent strain. In this central bent part of the crystal a few twin-lamellæ, corresponding to the Pericline system, are also seen crossing the former, though these too are wholly wanting at the ends where no flexure has been exerted. On examining the crystal in ordinary light with high powers, the two sets of twin-lamellæ are seen beautifully marked out by lines of cavities, some of which contain liquids, the position and degree of development of these lines of cavities exactly corresponding with those of secondary twinning.

Other interesting examples of the relation of solution-planes to the pre-existing lamellar twinning of crystals are afforded by some plagioclase-felspars which have undergone partial kaolinization. When such crystals are examined in ordinary light, two sets of lines, sometimes crossing one another nearly at right angles, can often be detected, along which the incipient decomposition has taken place. On examining the crystal with polarised light, these lines of incipient decomposition are also seen to coincide exactly with the Albite and Pericline twinning-planes of the felspar crystal, being displayed exactly in those areas of the crystals where either of these particular structures occur, and being seen to cross one another nearly at right angles in the parts where the two sets of twin-planes appear together. In this case the solvent action has taken place after the rocks have been brought near the surface by the denudation of overlying masses.

When the solvent action has gone still farther, enormous cavities, which

Digitized by Google

gradually become filled with secondary minerals, are developed along the planes of twinning, and sometimes also along the primary solution-planes of the crystal. This is admirably shown in a granulite from Arendal, Norway (Plate III. Fig. 6). Here we see a group of felspar crystals, along the solution-planes of which plates of secondary minerals have been formed, clearly marking out the original twin-structure of the felspar. Among the secondary minerals which appear to be thus formed are scapolite, wollastonite and zoisite.

As a final stage in this process of solution we find the skeleton of the original felspar crystal disappearing altogether, and the secondary product forming a pseudomorph after it. In this manner solvent action becomes an important adjunct to pressure in the transformation of the minerals of a rock from one species into another in metamorphosed rock-masses.

Explanation of Plate III.

Fig. I. represents a section of a faulted quartzite pebble from Stonehaven (see p. 83), as viewed with a magnifying power of 100 diameters. The separate sand-grains of which it is made up can be clearly distinguished, especially in polarised light. These grains of quartz contain the usual inclusions found in the quartzes of granitic rocks, such as irregular cavities with liquids and moving bubbles, acicular crystals of rutile, &c. But in addition to these, longer or shorter streams of bubbles are seen running through all the grains of quartz, quite irrespective of their orientation. Viewed with high powers, the cavities in these streams are seen to be of various sizes; they sometimes contain a liquid with moving bubble, and at other times are more or less completely filled with solid matter. The line of faulting in the pebble (* *) is clearly seen, filled up as it is with secondary calcite and quartz, and the general parallelism of these bands of cavities which run through all the grains, quite irrespectively of their optical orientation, is well marked and quite unmistakeable.

Fig. 2. Portion of a crystal of calcite which has been acted upon by very weak hydrochloric acid. The outer portion has been broken up into the solution-forms described by Von Ebner, but in the interior irregular cavities are making their appearance along certain planes, and some of these are beginning to assume the rectilinear outlines characteristic of negative crystals. The specimen is represented as seen with a magnifying power of 250 diameters. (See page 85.)

Fig. 3. Series of enclosures in a specimen of labradorite from Labrador, to illustrate the mode of development of negative crystals and

Digitized by Google

their infilling in that mineral. *a*, *b*, *c*, are magnified 100 diameters; *d*, *e*, *f*, *g*, 250 diameters. (See page 86.)

3 a. Group of iregular cavities all lying in one of the secondary solution-planes of the crystal, which in this case seems to be parallel to the basal-pinacoid (001). This appears to be determined as a solution-plane by the pre-existent lamellar "Pericline" twinning. Some of these cavities have been filled with secondary products, while others are apparently empty.

3 b. Similar group of cavities, some of which are assuming the rectilinear outlines of negative crystals. Moreover, the cavities lie within a field also bounded by rectilinear outlines.

3 c. Similar group of cavities lying within the field of a negative crystal; some of the cavities assume ramifying forms and are filled with secondary products.

3 d. Large enclosure made up of ramifying cavities, all lying parallel to the solution-plane, and terminating abruptly at the lines marking the boundary of a negative crystal. In one part, however, solution has gone farther, and the whole of this part of the negative crystal has been hollowed out. The areas in which solution has gone on are marked by the secondary deposits which have filled the spaces.

3 e. Negative crystal filled with secondary products. One half of the crystal is marked out by the ramifying cavities, similar to those shown in 3d. The other half is completely hollowed out and filled with a continuous deposit of secondary materials.

3 f. Similar negative crystals almost filled by a continuous deposit of secondary materials. While three of the sides are sharply defined by the edges of the negative crystal, the fourth side has the rugged outline so often seen in secondary inclusions, such for example as those of the hypersthene of Labrador.

3 g. Very perfect negative crystal, showing the characteristic forms of a labradorite crystal. The flat sides parallel to the solution-plane are the basal pinacoid (001), the outlines of the plate are formed by the two prism-planes (110) ($1\bar{1}0$) and the brachypinacoid (010).

This negative crystal, like the irregular spaces in the others figured, is filled with a yellowish and brownish isotropic substance. It varies greatly in depth of colour in different parts, and has none of the characters of a definite mineral species. It probably consists of hydrated silica (opal), more or less intensely coloured with the hydrated ferric oxides and other similar materials of secondary origin.

Fig. 4. Cleavage-rhomb of calcite which has been first twinned by

Digitized by Google

pressure on one of its corners, and then submitted to the action of weak hydrochloric acid. Owing to the combination and oscillation of the solvent actions along the normal solution-planes, —2 R ($\bar{1}11$), according to Von Ebner, the well-known etching figures with curved and striated surfaces have been formed on the cleavage faces. But where twinning has been produced, the secondary twin-plane —½ R (110), has become the solution-plane. In the intervals between these planes, an attempt to produce the ordinary etching figures has resulted in their partial development, but they are always cut off sharply by the new solution-planes, along which the solvent action has evidently been very energetic. The specimen is shown magnified 5 diameters. In other examples, I have succeeded in producing secondary twinning-planes so closely crowded together, that any tendency to form the ordinary etching figures seems to have been completely overcome. (See p. 87.)

Fig. 5. Section of a bent felspar-crystal in a gabbro from Humlebāk Scharf, Norway. Seen magnified 100 diameters. Following the secondary Albite and Pericline twinning-planes, cavities have been formed. Viewing the section between crossed Nicols, it is seen that not only do the lines of cavities exactly coincide in position with the twinning-planes, but that where the lamellar structure is well developed, there the cavities are largest and most abundant, while they altogether die out and disappear in the untwinned portions of the crystals. The relation of the twinning structure to the flexure of the crystal is unmistakeable. (See p. 89.)

Fig. 6. Group of felspar-crystals in a granulitic rock from Arendal, Norway. Magnified 50 diameters. More than half of these felspars has been replaced by secondary minerals. These are found to be developed in large cavities that have evidently been formed along the two great series of gliding planes in the crystals—the Albite and the Pericline systems. In addition to these, other sets of secondary inclusions, coinciding probably with the normal solution-planes, can in some cases be detected. (See p. 90.)

Digitized by Google

INDEX TO MINERALOGICAL PAPERS, &c. 1885.

By H. A. Miers, M.A.

Actinolite. W. Peyton. Min. Mag. VI. p. 126. *Scotland.*
v. Modena.

Adularia. C. Hintze. Zs. K. x. p. 489. *Cryst.*
C. Dölter. Zs. K. xi. p. 113. *Cryst.*

Agate. v. Modena.

Alabandite. C. Dölter. Zs. K. xi. p. 32. *Art.*

Alaskaite. G. Koenig. Proc. Am. Phil. Soc. xxii. p. 211. *Chem.*

Albertite. W. Morrison. Trans. Ed. Geol. Soc. v. p. 34. *Min.*

Albite. O. Lüdecke. Zs. K. x. p. 199. *Thuringia. Cryst.*
F. Sandberger. N. J. 1885 (1), p. 185. *Pseud. after Calcite.*

Allactite. J. Krenner. Zs. K. x. p. 83. *Opt.*
H. Sjögren. Zs. K. x. p. 114. *Mon.*

Allanite. C. Meminger. Am. Chem. J. vii. p. 177. *Nelson Co. Chem.*

Alunogen. Baret. Bull. Soc. Min. viii. p. 440. *St Nazaire.*

Amber. O. Helm. Schr. Ges. Danz. vi. (2), p. 234. *Mycenae.*
v. Modena.

Amblystegite. J. Judd. Geol. Mag. ii. p. 173. *Min.*

Amphibole. F. Becke. Min. Mitth. vii. p. 93. *Twinning.*
A. Becker. Zts. Geol. Ges. Berl. xxxvii. p. 10. *Fusion exper.*

Amphibole-Anthophyllite. G. Williams. N. J. 1885 (2), p. 175. *Baltimore.*

Analcite. C. Stadtländer. N. J. 1885 (2), p. 97. *Stempel. Cryst. Opt.*
A. Sauer. Zts. Geol. Ges. Berl. xxxvii. p. 453. *Pseud. after Leucite.*
S. Penfield. Am. J. Sc. xxx. p. 112. *Lake Superior.*
A. Lacroix. Bull. Soc. Min. viii. p. 357. *Opt. &c.*

Anatase. O. Lüdecke. Zs. K. x. p. 200. *Brand. Cryst.*
G. Cesaro. Bull. Soc. Min. viii. p. 396. *Cryst.*
G. Seligmann. Ber. Nied. Ges. Bonn. 1885, p. 118. *Rutile pseud. after.*
P. Groth. Ber. Ak. Münch. 1885, p. 400. *Dauphinée.*

Andes. G. Lallemant. An. Soc. Arg. xx. p. 123. *Min. of.*

Andesite. G. vom Rath. Ber. Nied. Ges. Bonn. 1885, pp. 209, 301. *Arcuentu.*
R. Maly. Ber. Ak. Wien. xci. (2), p. 65. *Trifail. Chem.*
F. Wiik. Öfv. Finsk. Vet. Förh. xxvii. p. 97. *Areskutan.*

Anglesite. A. Schmidt. Zs. K. x. p. 207. *Pelsőcz-Ardo.*

Anhydrite. A. Gorgeu. Ann. Chim. Phys. iv. p. 556. *Art.*
H. Vater. Zs. K. x. p. 390. *Cryst.*

Digitized by Google

ANORTHITE.	S. Meunier. C. R. c. p. 1350. *Art.*
ANTHRACITE.	M. Malagoli. Att. Soc. Nat. Mod. ii. p. 167. *Kimbote.*
	A. Ferguson. J. R. As. Soc. Ceyl. ix. (2), p. 171. *Ceylon.*
ANTIMONY.	G. Kunz. Am. J. Sc. xxx. p. 275. *New Brunswick.*
APATITE, &c.	F. Adams. Brit. Ass. 1884, p. 717. *Canada.*
	G. Brown. Brit. Ass. 1884, p. 716. *Quebec.*
	F. Sandberger. N. J. 1885 (1), p. 171. *Cont. Manganese.*
	T. Hunt. Min. J. liv. pp. 343, 450. *Canada;* and Can. Rec. i. p. 65.
	G. Moore and V. v. Zepharovich. Zs. K. x. p. 240. *Turquois pseud. after.*
	Dieulafait. Ann. Chim. Phys. v. p. 204. *Min.*
	Grossouvre. Ann. d. Min. vii. p. 361. *Central France.*
	G. Kinahan. Trans. Man. Geol. Soc. xviii. pp, 123, 132, *Ottawa;* and Proc. Dub. Soc. iv. p. 347.
	R. Bell. Eng. Min. J. xxxix. p. 317. *Canada.*
APOPHYLLITE.	F. Rinne. N. J. 1885 (2), p. 19. *Opt.*
	A. Lacroix. Bull. Soc. Min. viii. p. 355. *Opt. &c.*
ARAGONITE.	G. vom Rath. Ber. Nied. Ges. Bonn. 1885, p. 60. *Colorado.*
	Pohlig. Ber. Nied. Ges. Bonn. 1885, p. 141. *L. Urmiah.*
	E. Scacchi. Rendic. Ac. Nap. xxiv. p. 313. *Metamorphosed.*
	V. v. Ebner. Ber. Ak. Wien. xci. (2), p 760. *Etching.*
	v. Modena.
ARFVEDSONITE.	A. Kenngott. N. J. 1885 (2), p. 165. *Chem.*
ARLBERG.	H. Foullon. Jahrb. Geol. Reichs. xxxv. p. 90. *Min of.*
ARTIFICIAL MINERALS.	A. Gorgeu. Ann. Chim. Phys. iv. p. 515.
	I. Vogt. Bih. Vet. Ak. Hand. ix. i. *In Slags.*
ASBESTOS.	vid. Modena.
ASTRAKANITE.	Markownikoff. Bull. Soc. Chim. xliv. p. 383. *Chem.*
AUGITE.	C. Dölter. N. J. 1885 (1), p. 43. *Opt. Chem.*
	A. Knop. Zs. K. x. p. 58. *Kaiserstuhl. Chem.*
	I. Vogt. Bih. Vet. Ak. Hand. ix. i. p. 4. *Art.*
AXINITE.	A. Liversidge. R. Soc. N. S. W. xviii. p. 45. *N. S. Wales.*
	D. Porter. R. Soc. N. S. W. xviii. p. 80. *N. S. Wales.*
	P. Groth. Ber. Ak. Münch. 1885, p. 389. *Dauphinée.*
BARYTES.	T. Wallace. Min. Mag. vi. p. 168. *Scotland.*
	H. Foullon. Jahrb. Geol. Reichs. xxxv. p. 99. *Arlberg. Cryst.*
	A. Gorgeu. Ann. Chim. Phys. iv. p. 556. *Art.*
	F. Sansoni. Mem. Ac. Bol. vi. p. 471. *Vernasca. Cryst.*
	C. Busz. Zs. K. x. p. 32. *Mittelagger. Cryst.*
	A. Lacroix. Bull. Soc. Min. viii. p. 39. *Opt.*
	v. Dreelite, Modena.
BARYTO-CALCITE.	E. Mallard. Bull. Soc. Min. viii. p. 44. *Cryst. Opt.*
BASTITE.	v. Modena.
BAVENO.	M. Francesco. Att. Soc. It. Mil. xxviii. p. 58. *Min. of.*
BEEGERITE.	G. Koenig. Proc. Ac. Phil. 1885, p. 19. *San Juan Co.*; and Proc. Am. Phil. Soc. xxii. p. 211. *Chem.*

Digitized by Google

Beryl. H. Dufet. Bull. Soc. Min. viii. p. 261. *Therm. Opt.*
R. Baker. Am. Chem. J. vii. p. 175. *Amelia Co. Chem.*
J. O'Reilly. Proc. Dub. Soc. iv. p. 505. *Glencullen.*
D. Porter. R. Soc. N. S. W. xviii. p. 78. *N. S. Wales.*
F. Wiik. Öfv. Finsk. Vet. Förh, xxviii. p. 65. *Cryst.*

Berzeliite. G. Flink. Nyt. Mag. xxix. p. 301. Langban.

Blende. M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 36. *Silfberg.*
C. Tichborne. Proc. Dub. Soc. iv. p. 300. *Argentiferous (Kilmacooite).*
L. Sipöcz. Min. Mitth. vii. p. 285. *Hungary.*
A. v. Lasaulx. Ber. Nied. Ges. Bonn. 1885, p. 118. *Bensberg.*
Soltsien. Zts. Natwiss. Halle. iv. p. 297. *Aviles. Chem.*
v. Modena.

Boracite. H. Baumhauer. Zs. K. x. p. 451. *Cryst.*

Borax. E. Fuchs and F. Robellaz. Ann. d. Min. viii. p. 645. *California, Nevada.*

Botryolite. A. Lacroix. C. R. ci. p. 1165. *Opt.*; and Bull. Soc. Min. viii. p. 433.

Bournonite. L. Sipöcz. Min. Mitth. vii. p. 292. *Nagyag.*
C. Dölter. Zs. K. xi. p. 38. *Art.*

Bowlingite. A. Lacroix. C. R. ci. p. 1165. *Opt.*; and Bull. Soc. Min. viii. p. 97.

Braunite. L. Igelström. Bull. Soc. Min. viii. p. 421. *Wermland.*
C. Rammelsberg. Ber. Ak. Berl. 1885, p. 97. *Chem.*
v. Modena.

Brewsterite. A. Lacroix. Bull. Soc. Min. viii. p. 354. *Opt. &c.*

Brochantite. Atanasesco. Bull. Soc. Chim. xliii. p. 14. *Art.*

Bronzite. v. Modena.

Brucite. A. Lösch. Verh. Russ. Min. Ges. xx. p. 318. *Ural.*
A. de Schulten. C. R. ci. p. 72. *Art.*

Buratite. E. Jannettaz. Bull. Soc. Min. viii. p. 43. *Chem.*

Butte (Montana). G. vom Rath. N. J. 1885 (1), p. 158. *Min.*

Butyrellite. W. Macadam. Trans. Ed. Geol. Soc. v. p. 106. *Chem, not a min.*; and Min. Mag. vi. p. 175.

Calamine. Dieulafait. C. R. c. p. 815. *Origin of.*
A. Schmidt. Zs. K. x. p. 202. *Pelsöcz-Ardo.*
M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 18. *Silfberg.*

Calcite. H. Foullon. Jahrb. Geol. Reichs. xxxv. p. 91. *Arlberg. Cryst.*
F. Sandberger. N. J. 1885 (1), p. 185. *Quartz and Albite pseud. after.*
F. Schalch. N. J. Beil. Bd. iv. p. 187. *Dolomite pseud. after.*
M. Weibull. Min. Mitth. vii. p. 122. *Fusibility.*
A. Wichmann. Min. Mitth. vii. p. 256. *Fusibility.*
A. v. Lasaulx. Ber. Nied. Ges. Bonn. 1885, p. 230. *Opt.*
Friedel and E. Sarasin. Bull. Soc. Min. viii. p. 304. *Art.*
F. Sansoni. Bull. Ac. Belg. ix. p. 287. *Blaton. Cryst.*

Digitized by Google

CALCITE.
F. Sansoni. Zs. K. x. p. 545. *Andreasberg. Cryst.*
A. Schrauf. Zs. K. xi. p. 5. *Opt.*
E. Zschau. Isis. Ber. 1884, p. 57. *Nieder-Rabenstein.*
R. Solly. Min. Mag. vi. p. 120. *Shelve.*
V. v. Ebner. Ber. Ak. Wien. xci. (2), p. 760. *Etching.*
H. Foullon. Verh. Geol. Reichs. 1885, p. 148. *Deutsch-Altenberg.*
H. Foullon. Verh. Geol. Reichs. 1885, p. 149. *Leoben.*
F. Vogel. Pogg. xxv. p. 91. *Opt.*
v. Modena.

CALIFORNIA.
G. vom Rath. Ber. Nied. Ges. Bonn. 1885, pp. 246, 303, 344. *Min.*

CANADA.
W. Merrit. Brit. Ass. 1884, p. 719. *Min. of.*
R. Bell. R. Soc. Can. ii. p. 241. *Min. of N.*

CAPORCIANITE.
v. Modena.

CASSITERITE.
M. Miklucho-Maclay. N. J. 1885 (2), p. 88. *Ehrenfriedersdorf.*
J. Collins. Min. Mag. vi. p. xi. *Virginia.*
G. Cesaro. Bull. Soc. Min. viii. p. 102. *Cryst*

CATSEYE (QUARTZ).
A. Kenngott. N. J. 1885 (1), p. 239. *Magnetic.*

CELESTITE.
A. Caraven-Cachin. C. R. c. p. 923. *Saut.*
A. Gorgeu. Ann. Chim. Phys. iv. p. 556. *Art.*

CERITE, &c.
W. Crookes. Chem. News, li. p. 300. *Chem.*

CERUSSITE.
A. Schmidt. Zs. K. x. p. 204. *Pelsöcz-Ardo.*

CEVENNES.
Dieulafait. C. R. c. p. 469. *Minerals of, origin.*

CHABAZITE.
A. Lacroix. Bull. Soc. Min. viii. p. 360. *Opt. &c.*

CHALCEDONY.
v. Modena.

CHINA.
C. Gardner. J. R. As. Soc. China, xix. p. 1. *Min. of, Ichang.*

CHLORITE.
A. Lacroix. Bull. Soc. Min. viii. p. 98. *Bishoptown.*
M. Bird. Am. Chem. J. vii. p. 181. *Albemarle Co. Chem.*
A. Cathrein. Zs. K. x. p. 445. *Pseud. after Garnet.*

CHONDROARSENITE.
E. Bertrand. Bull. Soc. Min. viii. p. 374. *Opt.*

CHONDRODITE.
C. v. Wingard. Zts. Anal. Chem. xxiv. p. 344. *Chem.*

CHRISTIANITE.
A. Lacroix. Bull. Soc. Min. viii. p. 351. *Opt. &c.*

CHROMITE.
A. Liversidge. R. Soc. N. S. W. xviii. p. 45. *N. S. Wales.*

CHRYSOTILE.
E. Smith. Am. J. Sc. xxix. p. 32. *Shipton. Chem.*
A. Terreil. C. R. c. p. 251. *Chem.;* and Bull. Soc. Chim. xliv. p. 217.

CINNABAR.
C. Dölter. Zs. K. xi. p. 33. *Art.*
G. Tschermak. Min. Mitth. vii. p. 361. *Nikitowka.*

CLAY.
A. Damour. Bull. Soc. Min. viii. p. 305. *Nantes. Chem.*

CLINOCHLORE.
P. Jannasch. N. J. 1885 (1), p. 92. *Chem.*

COAL.
E. Bailey. Proc. Am. Ass. 1884, p. 171. *Kansas. Chem.*
E. Wethered. J. Mic. Soc. v. p. 406. *Structure of.;* and Proc. Cottes. Nat. 1885, p. 281.
G. Kinahan. Proc. Dub. Soc. iv. p. 364. *Ireland.*
H. Budden. Brit. Ass. 1884, p. 713. *Canada.*
N. Lupton. Chem. News, lii. p. 57. *U. S. A. Chem.*
v. Gold.

Digitized by Google

Cobaltite. J. Curie. Bull. Soc. Min. viii. p. 127. *Thermoel.*

Colemanite. T. Hiortdahl. Forh. Vid. Sels. Christ. 1884, 10. *Cryst. Chem.*; and Zs. K. x. p. 25. *Cryst.*

A. Arzruni. Zs. K. x. p. 272. *Cryst.*

G. v. Rath. N. J. 1885 (1), p. 77. *Cryst.*

A. Kenngott. N. J. 1885 (1), p. 241. *Chem.*

C. Bodewig and G. v. Rath. Zs. K. x. p. 179. *Mon.*

Colorado. G. v. Rath. Verh. Nat. Ver. Rheinl. corr. bl. p. 92. *Min.*

Columbite. J. Strüver. Zs. K. x. p. 85. *Piemont.*

Connellite. W. Semmons. Min. Mag. vi. p. 160. *Cornwall.*

H. Miers. Min. Mag. vi. p. 167. *Cornwall.*

C. Trechmann. Min. Mag. vi. p. 171. *Cornwall.*

Copper. v. Modena.

Copper-glance. C. Dölter. Zs. K. xi. p. 34. *Art.*

W. Jenks. Eng. Min. J. xl. p. 335. *New Mexico.*

Copper Pyrites. B. Lotti. Boll. Com. Geol. xvi. p. 254. *Monte Catini.*

C. Dölter. Zs. K. xi. p. 35. *Art.*

B. Blount. J. Chem. Soc. 1885, p. 593. *Chem.*

Cordierite. E. Hussak. N. J. 1885 (2), p. 82. *In Rocks.*

Corundum. A. v. Lasaulx. Zs. K. x. p 346. *Opt.* *Cryst.*; and Ber. Nied. Ges. Bonn. 1885, p. 81.

D. Porter. R. Soc. N. S. W. xviii. p. 77. *N. S. Wales.*

A. Lacroix. Bull. Soc. Min. viii. p. 440. *Loire.*

Baret. Bull. Soc. Min. viii. p. 438. *Loire.*

v. Sapphire.

Cosalite. G. Koenig. Proc. Am. Phil. Soc. xxii. p. 211. *Chem.*

Covellite. C. Dölter. Zs. K. xi. p. 34. *Art.*

Crocidolite. A. Kenngott. N. J. 1885 (2), p. 163. *Chem.*

Cryolite. H. Baumhauer. Zs. K. xi. p. 133. *Cryst.*

Crystals. A. Einhorn. Proc. Roy. Soc. xxxviii. p. 65. *Math.*

G. Stokes. Nature, xxxi. p. 565, xxxii. p. 224. *Opt.*

H. Madan. Nature, xxxi. p. 83, xxxii. pp. 102, 414. *Opt.*

T. Liebisch. N. J. 1885 (1), p. 45. *Opt.*

R. Brauns. N. J. 1885 (1), p. 96. *Opt.*

W. Voigt. N. J. 1885 (1), p. 119. *Pleochroism.*

O. Mügge. N. J. 1885 (2), p. 44. *Twinning.*

T. Liebisch. N. J. 1885 (2), p. 181. *Opt.*

C. Klein. N. J. 1885 (2), p. 237. *Opt.*

V. v. Ebner. Ber. Ak. Wien, xci. (2), p. 34. *Structure of.*

H. Pitsch. Ber. Ak. Wien, xci. (2), p. 527. *Isogyric Faces.*

Koepert. Zts. Natwiss. Halle, iv. p. 140. *In Plants.*

R. Rubenson. Öfv. Vet. Ak. Förh. 1884, 10, p. 3. *Opt.*

E. Sundberg. Öfv. Vet. Ak. Förh. 1885, 5, p. 77. *Math.*

K. Koch. Ber. Nat. Ges. Freib. viii. pp. 144, 314. *Elasticity.*

E. Blasius. Zs. K. xi. p. 140. *Therm.*

L. Wulff. Zs. K. xi. p. 120. *Growth of.*

J. Beckenkamp. Zs. K. x. p. 41. *Elasticity.*

A. Schrauf. Zs. K. x. p. 261. *Opt.*

Digitized by Google

CRYSTALS. E. Blasius. Zs. K. x. p. 221. *Decomposition Figures.*
O. Lehmann. Zs. K. x. p. 321. *Microsc. Growth.*
L. Wulff. Zs. K. x. p. 374. *Growth of.*
H. Dufet. Bull. Soc. Min. viii. p. 169. *Therm. Opt.*
P. Curie. Bull. Soc. Min. viii. p. 145. *Growth of.*
E. Mallard. Bull. Soc. Min. viii. p. 452. *Twinning.*
G. Wyrouboff. Bull. Soc. Min. viii. p. 398. *Isomerism, &c.*
G Basso. Att. Ac. Tor. xx. p. 537. *Opt.*; and N. C. xviii. pp. 84, 128.
M. Bellati and R. Romanese. Att. Ist. Ven. iii. p. 653. *Transformation Heat.*
P. Curie. C. R. c. p. 1393. *Math.*
M. Websky. N. J. 1885 (1), p. 79.
J. Tutschew. Verh. Russ. Min. Ges. xx. p. 130. *Math.*
E. Fedorow. Verh. Russ. Min. Ges. xxi. *Math.*

CUMBERLAND, &c. J. Goodchild. Trans. Cumb. Ass. ix. p. 175. *Min.*

CUPRITE. H. Lewis. Proc. Ac. Phil. 1885, p. 22. *Frankford.*

DATOLITE. O. Lüdecke. Zts. Natwiss. Halle, iv. pp. 87, 276. *Cryst.*; and Zs. K. x. p. 196.
M. Malagoli. Att. Soc. Nat. Mod. ii. p. 151. *Toggiana.*
v. Modena.

DAUPHINÉE. P. Groth. Ber. Ak. Münch. 1885, p. 371. *Min. of.*

DESCLOIZITE. F. Genth and G. v. Rath. Proc. Am. Phil. Soc. xxii. p. 369. *Lake Valley*; and Zs. K. x. p. 464.

DESMINE. C. Bodewig. Zs. K. x. p. 276. *Chem.*

DIADELPHITE. H. Sjögren. Zs. K. x. p. 130. *Mon.*

DIALLAGE. v. Modena.

DIAMOND. A. Moulle. Ann. d. Min. vii. p. 193. *S. Africa. Min.*
D. Porter. R. Soc. N. S. W. xviii. p. 97. *N. S. Wales.*
E. Jannettaz. Bull. Soc. Min. viii. p. 42. *Cryst.*

DIASPORE. v. Modena.

DIATOMITE. W. Macadam. Chem. News, lii. p. 253. *Chem.*

DIOPSIDE. G. Flink. Öfv. Vet. Förh. 1885, 2, p. 29. *Nordmark. Mon.*
A. Streng. N. J. 1885 (1), p. 238. *Zermatt. Chem. Cryst.*
v. Augite.

DOLIANITE. A. Lacroix. Bull. Soc. Min. viii. p. 356. *Opt. &c.*

DOLOMITE. H. Foullon. Verh. Geol. Reichs. 1885, p. 402. *Carrara.*
L. Bombicci. Mem. Ac. Bol. vi. p. 307. *Cryst.*
F. Schalch. N. J. Beil. Bd. iv. p. 187. *Pseud. after Calcite.*
v. Modena.

DREELITE. A. Lacroix. Bull. Soc. Min. viii. p. 435. *Opt.* = *Barytes.*

EMERALD. W. Hidden. Am. J. Sc. xxix. p. 250. *Alexander Co.*
Laflamme. R. Soc. Can. ii. p. 231. *Saguenay.*

ENARGITE. W. Semmons. Min. Mag. vi. p. 124. *Montana.*

ENDLICHITE. F. Genth and G. v. Rath. Zs. K. x. p. 462. *Lake Valley. New Min.*; and Proc. Am. Phil. Soc. xxii. p. 367.

ENSTATITE. I. Vogt. Bih. Vet. Ak. Hand. ix. 1, p. 24. *Art.*

Digitized by Google

EPIDOTE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvii. p. 76. *Pargas. Chem.*
	P. Groth. Ber. Ak. Münch. 1885, p. 389. *Dauphinée.*
	A. Cathrein. Zs. K. x. p. 435. *Pseud after Garnet.*
	A. Dana. Zs. K. x. p. 490. *Rowe. Chem.*
EPISTILBITE.	C. Bodewig. Zs. K. x. p. 276. *Chem.*
	A. Lacroix. Bull. Soc. Min. viii. p. 343. *Opt. &c.*
ERUBESCITE.	H. Baumhauer. Zs. K. x. p. 447. *New Mexico.*
	C. Dölter. Zs. K. xi. p. 36. *Art.*
ERYTHRITE.	H. Lewis. Proc. Ac. Phil. 1885, p. 120. *Phœnixville.*
ERZGEBIRGE.	F. Schalch. N. J. Beil. Bd. iv. p. 178. *Min.*
EUDNOPHITE.	A. Lacroix. Bull. Soc. Min. viii. p. 359. *Opt. &c.*
FAIRFIELDITE.	F. Sandberger. N. J. 1885 (1), p. 185. *Rabenstein.*
FAYALITE.	A. Gorgeu. Ann. Chim. Phys. iv. p. 540. *Art.*
	W. Hidden. Am. J. Sc. xxix. p. 250. *Colorado.*
	J. Iddings. Am. J. Sc. xxx. p. 58. *Yellowstone Park.*
FELSPAR.	B. Lotti. Boll. Com. Geol. xvi. p. 57. *Cagliari.*
FELSPAR AND MICA.	A. Sauer. Zts. Geol. Ges. Berl. xxxvii. p. 466. *Pseud. after Leucite.*
FICHTELITE.	M. Schuster. Min. Mitth. vii. p. 88. *Salzendeich.*
FLUOR.	F. Gonnard. Bull. Soc. Min. viii. pp. 9, 31. *Pontgibaud.*
	F. Gonnard. Bull. Soc. Min. viii. p. 151. *Rhône.*
	W. Voigt. N. J. Beil. Bd. iv. p. 228. *Elasticity.*
	M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 39.
	H. Dufet. Bull. Soc. Min. viii. p. 257. *Therm. Opt.*
	E. Scacchi. Rendic. Ac. Nap. xxiv. p. 314. *Vesuvius.*
FRANKLINITE.	F. Becke. Min. Mitth. vii. p. 224. *Etching.*
GAHNITE.	A. Dana. Am. J. Sc. xxix. p. 455. *Rowe, Chem.*; and Zs. K. x. p. 490.
GALENA.	M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 38. *Silfberg.*
	Quiroga. An. Soc. Esp. Hist. Nat. (Act) 1885, p. 6. *Cryst.*
	C. Dölter. Zs. K. xi. p. 33. *Art.*
	v. Modena.
GARNET.	A. Cathrein. Zs. K. x. p. 433. *Alteration of.*
GEHLENITE.	I. Vogt. Bih. Vet. Ak. Handl. ix. 1, p. 123. *Art.*
GENTHITE.	H. Lewis. Proc. Ac. Phil. 1885, p. 121. *Lafayette.*
GERHARDTITE.	H. Wells and S. Penfield. Am. J. Sc. xxx. p. 50. *New Min.*
GISMONDITE.	A. Lacroix. Bull. Soc. Min. viii. p. 364. *Opt. &c.*
GMELINITE.	A. Lacroix. Bull. Soc. Min. viii. p. 363. *Opt. &c.*
GOETHITE.	A. Lacroix. Bull. Soc. Min. viii. p. 41. *Chizeuil, &c.*
	E. Palla. Zs. K. xi. p. 23. *Cryst.*
GOLD.	A. Noguès. C. R. ci. p. 81 *Penaflor.*
	R. Canaval. Jahrb. Geol. Reichs. xxxv. p. 105. *Paternion.*
	E. Dunn. Geol. Mag. ii. p. 171. *Transvaal, Min.*
	A. Leibus. R. Soc. N. S. W. xviii. p. 37. *Queensland.*
	A. Liversidge. R. Soc. N. S. W. xviii. p. 43. *N. S. Wales.*
	W. Allen. Proc. Dub. Soc. iv. p. 509. *Art.*
	Laflamme. R. Soc. Can. ii. p. 227. *Beauce.*

Digitized by Google

GOLD.	W. Penning. Q. J. Geol. Soc. xli. p. 569. *Transvaal.*
	C. Bolker. Eng. Min. J. xl. p. 367. *Honduras.*
	v. Modena.
GOLD AND COAL.	E. Gilpin. Brit. Ass. 1884, p. 711. *Nova Scotia.*
GONIOMETER.	T. Liebisch. N. J. 1885 (1), p. 76.
GRAPHITE.	H. Putz. Ber. Nat. Ver. Pass. xiii. p. 69. *Passau.*
	H. Sjögren. Min. Mag. vi. p. 151. *Cryst.*
	W. Macadam. Min. Mag. vi. p. 172. *Aberdeen, Chem.*
	J. Woldrich. Verh. Geol. Reichs. 1885, p. 399. *Schwarzbach.*
	A. Ferguson. J. R. As. Soc. Ceyl. ix. (2), p. 171. *Ceylon.*
GRAPHITOID.	A. Sauer. Zts. Geol. Ges. Berl. xxxvii. p. 441. *Erzgebirge.*
GROSSULAR.	A. Gorgeu. Ann. Chim. Phys. iv. p. 553. *Art.*
GYPSUM.	M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 34. *Silfberg.*
	F. v. Hauer. Verh. Geol. Reichs. 1885, p. 21. *Gams.*
	M. Mario. Att. Soc. Nat. Mod. ii. p. 73. *Cryst.*
	E. Blasius. Zs. K. x. p. 234. *Decomposition Figures.*
	G. Cesaro. Bull. Soc. Min. viii. p. 317. *Cryst.*
	A. Jonquière. Mitth. Nat. Ges. Bern. 1885, p. 61. *Opt.*
	v. Modena.
HÆMAFIBRITE.	H. Sjögren. Zs. K. x. p. 126. *Mon.*
HÆMATITE.	W. Gresley. Q. J. Geol. Soc. xli. (Proc.) p. 109. *Leicestershire.*
	S. Meunier. C. R. ci. p. 889. *Art.*
	H. Vater. Zs. K. x. p. 391. *Art. Cryst.*
	F. Schalch. N. J. Beil. Bd. iv. p. 193. *Magnetite pseud. after.*
	v. Modena.
HÆMATOLITE.	v. Diadelphite.
HÆMATOSTIBIITE.	L. Igelström. Bull. Soc. Min. viii. p. 143. *New Min.*
HANKSITE.	W. Hidden. Am. J. Sc. xxx. p. 133. *New Min. California.*
	E. Dana and S. Penfield. Am. J. Sc. xxx. p. 136. *Cryst. Chem.*
HERDERITE.	A. Weisbach. N. J. 1885 (1), p. 154. *Chem.*
	C. Winkler. N. J. 1885 (1), p. 172. *Chem.*
	A. DesCloizeaux and A. Damour. Bull. Soc. Min. viii. p. 3. *Chem.*
	F. Genth. Chem. News, li. p. 86. *Chem.*
HERSCHELITE.	A. Lacroix. Bull. Soc. Min. viii. p. 362. *Opt. &c.*
HEULANDITE.	A. Lacroix. Bull. Soc. Min. viii. p. 348. *Opt. &c.*
	C. Bodewig. Zs. K. x. p. 276. *Chem.*
HIDDENITE.	W. Hidden. Am. J. Sc. xxix. p. 250. *Alexander Co.*
	T. Bouvé. Proc. Bos. Soc. xxiii. p. 2. *Gem.*
HORNBLENDE.	B. Kolenko. N. J. 1885 (2), p. 90. *Pseud. after Olivine.*
	G. Williams. N. J. 1885 (2), p. 175. *St. Lawrence Co.*
	A. Cathrein. Zs. K. x. p. 441. *Pseud. after Garnet.*
	K. Oebbeke. Bull. Soc. Min. viii. p. 52. *Mt. Dore.*
HULLITE.	A. Lacroix. C. R. ci. p. 1165. *Opt.*; and Bull. Soc. Min. viii. p. 432.
HUMITE.	C. v. Wingard. Zts. Anal. Chem. xxiv. p. 344. *Chem.*

Digitized by Google

HYDROCERUSSITE. A. Lacroix. Bull. Soc. Min. viii. p. 65. *Wanlockhead.*

HYDROGIOBERTITE. E. Scacchi. Rendic. Ac. Nap. xxiv. p. 310. *New Min.*

HYPERSTHENE. K. Oebbeke. Bull. Soc. Min. viii. p. 50. *Mt. Dore.*
A. Schmidt. Zs. K. x. p. 210. *Malnas.*

IDOCRASE. A. Liversidge. R. Soc. N. S. W. xviii. p. 45. *N. S. Wales.*
D. Porter. R. Soc. N. S. W. xviii. p. 80. *N. S. Wales.*

IGELSTRÖMITE. M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 19. *Silfberg* (*Iron-Knebelite*).
v. Olivine group.

ILMENITE. E. Chapman. R. Soc. Can. ii. p. 159. *Ontario.*

INDIA. V. Ball. Brit. Ass. 1884, p. 731. *Min. of.*

IODARGYRITE. F. Genth and G. v. Rath. Zs. K. x. p. 473. *Lake Valley.*

IODYRITE. F. Genth and G. v. Rath. Proc. Am. Phil. Soc. xxii. p. 375. *Lake Valley.*

IRON ORES. G. Kinahan. Proc. Dub. Soc. iv. p. 306. *Ireland.*
P. Trasenster. Rev. d. Min. xviii. p. 458. *United States.*

IRON-RHODONITE. M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 29. *New Min.*

ITACOLUMITE. G. Spezia. Att. Ac. Tor. xxi. p. 51. *Flexibility.*

JAMESONITE. C. Dölter. Zs. K. xi. p. 40. *Art.*

KAOLINITE. E. Valentine. Am. Chem. J. vii. p. 178. *Nelson Co. Chem.*

KILMACOOITE. v. Blende.

KIRWANITE. A. Lacroix. C. R. ci. p. 1164. *Opt.;* and Bull. Soc. Min. viii. p. 428.

KNEBELITE. M. Weibull. Min. Mitth. vii. p. 112. *Silfberg, Chem.*
M. Weibull. Min. Mitth. vii. p. 119. *Dannemora, Chem.*
A. Gorgeu. Ann. Chim. Phys. iv. p. 543. *Art.*
v. Olivine group.

KOBELLITE. H. F. and H. A. Kellar. J. Am. Chem. Soc. vii. p. 194. *Leadville.*

KREMS. E. Drasche. Verh. Geol. Reichs. 1885, p. 81. *New Min. from.*

KRENNERITE. L. Sipöcz. Min. Mitth. vii. p. 264. *Nagyag, Chem.*

KUSSINSK. M. Melnikow. Verh. Russ. Min. Ges. xx. p. 237. *Min. of.*

LABRADORITE. v. Modena.

LAUMONTITE. F. Schalch. N. J. Beil. Bd. iv. p. 186. *Erzgebirge.*
A. Lacroix. Bull. Soc. Min. viii. p. 339. *Opt. &c.*

LEAD ORES. M. Websky. Ber. Ak. Berl. 1885, p. 95. *Cordova, Vanadates.*

LEUCITE. C. Klein. N. J. 1885 (2), p. 234. *Cryst.*
C. Klein. N. J. Beil. Bd. iii. p. 522. *Cryst. Opt.*
H. Rosenbusch. N. J. 1885 (2), p. 59. *Cryst.*
A. Sauer. Zts. Geol. Ges. Berl. xxxvii. p. 453. *Pseud. after.*
E. Scacchi. Rendic. Ac. Nap. xxiv. p. 315. *Altered.*

LEVYNITE. A. Lacroix. Bull. Soc. Min. viii. p. 361. *Opt. &c.*

LIGNITE. v. Modena.

LIGURIA. L. Mazzuoli. Boll. Com. Geol. xvi. p. 193. *Copper Ores.*

Digitized by Google

LIMONITE. J. Welch. Chem. News, lii. p. 32. *Chem.*
v. Modena.

LINNÆITE. F. Becke. Min. Mitth. vii. p. 225. *Etching.*

LITHOMARGE. A. Liversidge. R. Soc. N. S. W. xviii. p. 45. *N. S. Wales.*

LITTAI. A. Brumlechner. Jahrb. Geol. Reichs. xxxv. p. 387. *Min. of.*

LUDWIGITE. A. Renard. Bull. Ac. Belg. ix. p. 547. *Opt.*

MAGNETITE. F. Becke. Min. Mitth. vii. p. 200. *Etching.*
M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 13. *Silfberg* (*Mangano-*); and Min. Mitth. vii. p. 109.
F. Schalch. N. J. Beil. Bd. iv. p. 193. *Pseud. after Hæmatite.*

MALACHITE. v. Modena.

MALACOLITE. M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 34. *Silfberg.*

MANGANESE ORES. E. Gilpin. R. Soc. Can. ii. p. 7. *Nova Scotia.*

MANGANHEDENBERGITE. M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 33. *Silfberg.*

MANGANHISINGERITE. M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 21. *Silfberg;* and Min. Mitth. vii. p. 113.

MANGANITE. C. Rammelsberg. Ber. Ak. Berl. 1885, p. 97. *Chem.*
v. Modena.

MANGANO-CALCITE. M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 14. *Silfberg;* and Min. Mitth. vii. p. 110.

MANGANO-MAGNETITE. G. Flink. Nyt. Mag. xxix. p. 303. *New Min. Langban.*
v. Magnetite.

MARCASITE. C. Dölter. Zs. K. xi. p. 31. *Art.*
v. Modena.

MARTITE. F. Schalch. N. J. Beil. Bd. iv. p. 189. *Rittersgrün.*
F. Gonnard. Bull. Soc. Min. viii. p. 308. *Cryst.*

MELILITE. I. Vogt. Bih. Vet. Ak. Hand. ix. 1, p. 105. *Art.*

MESITITE. M. Malagoli. Att. Soc. Nat. Mod. ii. p. 169. *Scandiano.*
v. Modena.

MESOTYPE. F. Gonnard. Bull. Soc. Min. viii. p. 123. *Cryst.*
A. Lacroix. Bull. Soc. Min. viii. p. 332. *Opt. &c.*

MESOLITE. A. Lacroix. Bull. Soc. Min. viii. p. 338. *Opt. &c.*

METACINNABARITE. S. Penfield. Am. J. Sc. xxix. p. 452. *Cryst.*

MIARGYRITE. C. Dölter. Zs. K. xi. p. 39. *Art.*

MICA. F. Sandberger. N. J. 1885 (1), p. 171. *With Boron.*
C. Rammelsberg. N. J. 1885 (2), p. 225. *Branchville, Chem.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1885, p. 57. *Branchville.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1885, p. 58. *Portland, Conn.*
A. Lacroix. Bull. Soc. Min. viii. p. 99. *Templeton.*
I. Vogt. Bih. Vet. Ak. Hand. ix. 1, p. 89. *Art.*
v. Modena.

MICROLITE. C. Hintze. Zs. K. x. p. 86. *Opt.*

MILARITE. F. Rinne. N. J. 1885 (2), p. 1. *Cryst.*

MILLERITE. G. Seligmann. Verh. Nat. Ver. Rhein. Corr. bl. p. 73. *Cryst.*

MINERALS. Erhard. Jahrb. B. H. Sachs. p. 175. *Elect.*
Dieulafait. C. R. c. pp. 469, 662, ci. pp. 324, 609, 644, 676. *Origin of.*

Digitized by Google

MINERALS. A. Inostranzeff. C. R. c. p. 1396. *Microsc.*; and N. J. 1885 (2), p. 94.
J. Ady. Min. Mag. vi. p. 127. *Sections.*
E. Bertrand. Bull. Soc. Min. viii. p. 30. *Opt.*

MINERAL-VEINS. C. Foster. Brit. Ass. 1884, p. 732.
Erhard. Jahrb. B. H. Sachs. p. 160. *Elect.*

MISPICKEL. P. Groth. Ber. Ak. Münch. 1885, p. 383. *Allemont.*
M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 35. *Silfberg.*

MODENA. M. Malagoli. Att. Soc. Nat. Mod. ii. p. 30. *Min. of.*

MONAZITE. H. Gorceix. Bull. Soc. Min. viii. p. 32. *Bolivia.*
H. Gorceix. C. R. c. p. 356. *Bahia, Chem.*
H. Miers. Min. Mag. vi. p. 164. *Cornwall.*

MONIMOLITE. G. Flink. Nyt. Mag. xxix. p. 304. *Pajsberg.*

MONT DORE. K. Oebbecke. Bull. Soc. Min. viii. p. 46. *Min.*
F. Gonnard. Bull. Soc. Min. viii. p. 310. *Min.*

MONTECASTELLI. B. Lotti. Boll. Com. Geol. xvi. p. 82. *Copper Ores.*

NAGYAGITE. L. Sipöcz. Min. Mitth. vii. p. 267. *Nagyag, Chem.*

NATROLITE. C. Stadtländer. N. J. 1885 (2), p. 113. *Stempel. Cryst. Opt.*

NEPHRITE. C. Hintze. Ber. Nied. Ges. Bonn. 1885, p. 143.
A. Kenngott. N. J. 1885 (1), p. 239. *Jordansmühl.*
H. Traube. N. J. 1885 (2), p. 91. *Jordansmühl.*
C. Bodewig. Zs. K. x. p. 86. *Tasmania.*

NEW MINERALS. v. Endlichite, Gerhardtite, Hæmatostibiite, Hanksite, Hydrogiobertite, Iron-rhodonite, Krems, Mangano-magnetite, Polyarsenite, Selenides, Synadelphite, Uintahite.

NEW MINERAL. H. Keller. Eng. Min. J. xl. p. 20. *Leadville.*

NICCOLITE. L. Sipöcz. Min. Mitth. vii. p. 281. *Dobsina, Chem.*

N. S. WALES. A. Liversidge. R. Soc. N. S. W. xviii. p. 43. *Min. of.*
D. Porter. R. Soc. N. S. W. xviii. p. 75. *Min. of.*

OKENITE. A. Lacroix. Bull. Soc. Min. viii. p. 341. *Opt. &c.*

OLIGOCLASE. A. Cathrein. Zs. K. x. p. 437. *Pseud. after Garnet.*
A. DesCloizeaux and Pisani. Bull. Soc. Min. viii. p. 6. *Opt. Chem.*

OLIVINE. I. Vogt. Bih. Vet. Ak. Hand. ix. 1, p. 45. *Art.*
E. Kalkowsky. Zs. K. x. p. 17. *Cryst.*
B. Kolenko. N. J. 1885 (2), p. 90. *Hornblende pseud. after.*
A. Becker. Zts. Geol. Ges. Berl. xxxvii. p. 15. *Origin of.*

OLIVINE GROUP. M. Weibull. Ofv. Vet. Ak. Förh. 1885, 2, p. 3.

ORTHITE. O. Lüdecke. Zs. K. x. p. 187. *Thuringia, Cryst.*

ORTHOCLASE. V. v. Zepharovich. Ber. Ak. Wien. xci. (1), p. 158. *In Basalt*; and Zs. K. x. p. 601.
F. Gonnard. C. R. ci. p. 76. *Cryst.*; and Bull. Soc. Min. viii. p. 307.
E. Scacchi. Rendic. Ac. Nap. xxiv. p. 315. *Pseud. after Leucite.*
C. Hintze. Ber. Nied. Ges. Bonn. 1885, p. 275. *Cryst.*
v. Modena.

Digitized by Google

OZOCERITE.	v. Petroleum.
PANDERMITE.	A. Kenngott. N. J. 1885 (1), p. 241. *Chem.*
PARISITE.	G. de Grandmaison. Min. Mag. vi. p. 123. *Cryst.*
PECTOLITE.	A. Lacroix. Bull. Soc. Min. viii. p. 323. *Opt. &c.*
PELSÖCZ-ARDO.	A. Schmidt. Zs. K. x. p. 202. *Min.*
PEROFSKITE.	A. Sauer. Zts. Geol. Ges. Berl. xxxvii. p. 445. *Wiesenthal.*
PETROLEUM.	J. Le Bel. Bull Soc. Colm. 1885, p. 445. *Pechelbronn.*
	v. Modena.
PETROLEUM & OZOCERITE.	L. Cyroczynski. Rev. d. Min. xix. p. 1. *Min.*
PHACOLITE.	C. Bodewig. Zs. K. x. p. 276. *Chem.*
PHENACITE.	W. Hidden. Am. J. Sc. xxix. p. 249. *Colorado.*
	G. Seligmann. Ber. Nied. Ges. Bonn. 1885, p. 168. *Wallis.*
PHILLIPSITE.	C. Stadtländer. N. J. 1885 (2), p. 122. *Stempel, Cryst. Opt.*
PHOSPHATES.	G. Hughes. Q. J. Geol. Soc. xli. p. 80. *N. S. Wales.*
PHOSPHORITE.	O. Helm. Schr. Ges. Danz. vi. (2), p. 240. *Chem.*
	P. Thomas. C. R. ci. p. 1184. *Tunis.*
PICROMERITE.	O. Lüdecke. Zts. Natwiss. Halle, iv. p. 651. *Stassfurt, Cryst.*
PINNOITE.	O. Lüdecke. Zts. Natwiss. Halle, iv. p. 645. *Stassfurt, Cryst.*
PITCHBLENDE.	v. Uraninite.
PLATTNERITE.	O. Lüdecke. Zts. Natwiss. Halle, iv. p. 201. *Art. Cryst.*
PLUMBOCALCITE.	A. Lacroix. Bull. Soc. Min. viii. p. 36. *Wanlockhead.*
POLARISCOPE.	T. Liebisch. N. J. 1885 (1), p. 175.
POLYARSENITE.	L. Igelström. Bull. Soc. Min. viii. p. 369. *New Min.*
	E. Bertrand. Bull. Soc. Min. viii. p. 374. *Opt.*
PREHNITE.	A. Lacroix. Bull. Soc. Min. viii. p. 326. *Opt. &c.*
	F. Schalch. N. J. Beil. Bd. iv. p. 179. *Erzebirge.*
	v. Modena.
PRICEITE.	A. Kenngott. N. J. 1885 (1), p. 241. *Chem.*
PROUSTITE.	E. Rethwisch. N. J. Beil. Bd. iv. p. 31. *Mon.*
PSEUDOBROOKITE.	K. Oebbeke. Bull. Soc. Min. viii. p. 56. *Mt. Dore.*
PSILOMELANE.	v. Modena.
PYRARGYRITE.	E. Rethwisch. N. J. Beil. Bd. iv. p. 31. *Mon.*
PYRITES.	Drinkwater. Anal. x. p. 109. *Chem.*
	M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 38.
	M. Mario. Att. Soc. Nat. Mod. ii. p. 95. *S. Ruffino.*
	A. Purgold. Isis. Ber. 1884, p. 25. *Cryst.*
	P. Groth. Ber. Ak. Münch. 1885, p. 378. *Dauphinés.*
	B. Lotti. Boll. Com. Geol. xvi. p. 254. *Montecatini.*
	L. Brugnatelli. Att. Ac. Tor. xx. p. 808. *Brosso, Cryst.*
	A. Liversidge. R. Soc. N. S. W. xviii. p. 45. *N. S. Wales.*
	J. Curie. Bull. Soc. Min. viii. p. 127. *Thermoel.*
	C. Dölter. Zs. K. xi. p. 30. *Art.*
	v. Modena.
PYROMORPHITE.	M. Mario. Att. Soc. Nat. Mod. ii. p. 98. *M. Galbone.*
PYROXENE.	A. Becker. Zts. Geol. Ges. Berl. xxxvii. p. 10. *Fusion Exper.*
	F. Becke. Min. Mitth. vii. p. 93. *Twinning.*
	A. Gorgeu. Ann. Chim. Phys. iv. p. 554. *Art.*
	K. de Kroustchoff. Bull. Soc. Min. viii. p. 85. *Roesberg.*

Digitized by Google

PYRRHOTITE. M. Weibull. Ofv. Vet. Ak. Förh. 1884, 9, p. 39.

QUARTZ. K. Exner. Pogg. xxv. p. 141. *Opt.*; and Ber. Ak. Wien. xci. (2), p. 218.
O. Tumlirz. Ber. Ak. Wien. xcii. (2), p. 301. *Magnetic.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1885, pp. 59, 235, 301. *N. Carolina*; and Zs. K. x. pp. 156, 475.
A. v. Lasaulx. Ber. Nied. Ges. Bonn. 1885, p. 227. *Tiger's-eye.*
E. Fellenberg. Mitth. Nat. Ges. Bern. 1885, p. 99. *Bex.*
P. Groth. Ber. Ak. Münch. 1885, p. 386. *Bourg d'Oisans.*
D. Porter. R. Soc. N. S. W. xviii. p. 75. *N. S. Wales.*
S. Meunier. C. R. c. p. 1398.
J. de Lepinay. C. R. ci. p. 874. *Opt.*
H. Foullon. Verh. Geol. Reichs. 1885, p. 402. *Carrara.*
W. Frazer. Proc. Irish Ac. ii. p. 290. *Archæological.*
Quiroga. An. Soc. Esp. Hist. Nat. (Act.) p. 10. *Cryst.*
M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 40.
F. Sandberger. N. J. 1885 (1), p. 185. *Pseud. after Calcite.*
W. Brown. Am. J. Sc. xxx. p. 191. *Twins.*
v. Modena.

REDRUTHITE. M. Mario. Att. Soc. Nat. Mod. ii. p. 98. *M. Galbone.*

RHABDOPHANE. G. Brush & S. Penfield. Zs. K. x. p. 82. *Connecticut.*

RHODONITE. M. Weibull. Min. Mitth. vii. p. 117. *Silfberg, Chem.*
A. Gorgeu. Ann. Chim. Phys. iv. p. 523. *Art.*
I. Vogt. Bih. Vet. Ak. Hand. ix. i. p. 37. *Art.*

RUTILE. F. Rinne. N. J. 1885 (2), p. 20. *Cryst.*
M. Miklucho-Maclay. N. J. 1885 (2), p. 88. *Ehrenfriedersdorf.*
W. Hidden. Am. J. Sc. xxix. p. 250. *Alexander Co.*
A. Lacroix. Bull. Soc. Min. viii. p. 99. *Templeton.*
G. Seligmann. Ber. Nied. Ges. Bonn. 1885, p. 118. *Pseud. after Anatase.*

SAFFLORITE. L. McCay, Am. J. Sc. xxix. p. 369. *Massive.*

SALT. O. Lüdecke. Zts. Natwiss. Halle, iv. p. 662. *Cryst.*
H. Cadell. Trans. Ed. Geol. Soc. v. p. 92. *Stassfurt.*
S. Langley. Am. J. Sc. xxx. p. 477. *Opt.*
W. Voigt. N. J. Beil. Bd. iv. p. 228. *Elasticity.*
v. Modena.

SAMARSKITE, &c. J. Smith. Chem. News, li. pp. 288, 304. *Chem.*

SAPPHIRE. V. Ball. Proc. Dub. Soc. iv. p. 393. *Himalayas.*

SARDINIA. G. v. Rath. Ber. Nied. Ges. Bonn. 1885, p. 172. *Min.*

SASSOLITE. Dieulafait. C. R. c. pp. 1017, 1240. *Origin of.*

SAUSSURITE. A. Cathrein. Zs. K. x. p. 444. *Pseud. after Garnet.*
v. Modena.

SCAPOLITE. A. Cathrein. Zs. K. x. p. 434. *Pseud. after Garnet.*
G. Tschermak. N. J. 1885 (2), p. 72. *Chem.*

Digitized by Google

Scapolite Group.	C. Rammelsberg. Ber. Ak. Berl. 1885, p. 589. *Chem.*
Scherlite.	A. Liversidge. R. Soc. N. S. W. xviii. p. 44. *N. S. Wales.*
	G. Flink. Nyt. Mag. xxix. p. 300. *Nordmark.*
Scolecite.	G. Freda. Rendic. Ac. Nap. xxiv. p. 205. *Vesuvius.*
	C. Friedel and A. de Gramont. Bull. Soc. Min. viii. p. 75. *Pyroel.*
Scorodite.	P. Jeremejew. Verh. Russ. Min. Ges. xx. p. 185. *Ekaterinburg.*
Scovillite.	v. Rhabdophane.
Selenides.	F. Heusler and H. Klinger. Ber. Chem. Ges. Berl. xviii. p. 2556. *Andes.*
Selenite.	R. Breñosa. An. Soc. Esp. Hist. Nat. (Act), p. 52. *Cryst.*
Semseyite.	L. Sipöcz. Min. Mitth. vii. p. 283. *Chem.*
Sericolite.	v. Modena.
Serpentine.	v. Modena.
Silfberg.	M. Weibull. Öfv. Vet. Ak. Förh. 1884, 9, p. 11. *Min. of.*
Silfbergite.	M. Weibull. Min. Mitth. vii. p. 115. *Chem.*; and Öfv. Vet. Ak. Förh. 1884, 9, p. 24.
Silicates.	T. Hunt. Brit. Ass. 1884, p. 679. *Chem.*
	T. Hunt. Can. Rec. i. pp. 129-224. *Classification.*
	L. Patterson. Am. Chem. J. vii. p. 180. *Nelson Co. Chem.*
Silver Ores.	M. Websky. Ber. Ges. Nat. Fr. Berl. 1885, p. 135. *Rudelstadt.*
Spessartite.	A. Gorgeu. Ann. Chim. Phys. iv. p. 536. *Art.*
Sphene.	G. Williams. Am. J. Sc. xxix. p. 486. *Cleavage.*
Spinel.	F. Becke. Min. Mitth. vii. p. 224. *Etching.*
	A. Gorgeu. Ann. Chim. Phys. iv. p. 544. *Art.*
	I. Vogt. Bih. Vet. Ak. Hand. ix. 1, p. 148. *Art.*
Spodumene.	T. Bouvé. Proc. Bos. Soc. xxiii. p. 2. *Gem.*
Stassfurt.	O. Lüdecke. Zts. Natwiss. Halle, iv. p. 645. *Min.*
Staurolite.	Coloriano. Bull. Soc. Chim. xliii. p. 427. *Chem.*
	W. Friedl. Zs. K. x. p. 366. *Chem.*
Steatite.	v. Modena.
Stephanite.	G. v. Rath. Zs. K. x. p. 173. *Mexico, Cryst.*
Stilbite.	A. Lacroix. Bull. Soc. Min. viii. p. 345. *Opt. &c.*
Strengite.	A. de Schulten. C. R. c. p. 1522. *Art.*
Strontianite.	W. Macadam. Min. Mag. vi. p. 173. *Strontian, Chem.*
Struvite.	M. Malagoli. Att. Soc. Nat. Mod. ii. p. 168. *Mejillones.*
	E. Kalkowsky. Zs. K. xi. p. 1. *Homburg, Cryst.*
Sulphur.	H. v. Foullon. Verh. Geol. Reichs. 1885, p. 146. *Galicia.*
	v. Modena.
Svanbergite.	L. Igelström. Bull. Soc. Min. viii. p. 424. *Wermland.*
Sylvanite.	L. Sipöcz. Min. Mitth. vii. p. 262. *Chem.*
Synadelphite.	H. Sjögren. Zs. K. x. p. 143. *Mon.*
Talc.	v. Modena.
Tephroite.	I. Vogt. Bih. Vet. Ak. Hand. ix. 1, p. 58. *Art.*
	A. Gorgeu. Ann. Chim. Phys. iv. p. 523. *Art.*
Tetrahedrite.	T. Liweh. Zs. K. x. p. 488. *Colorado, Cryst.*
	P. Jeremejew. Verh. Russ. Min. Ges. xx. p. 323. *Beresowsk.*

Digitized by Google

THENARDITE. v. Modena.

THOMSONITE. A. Lacroix. Bull. Soc. Min. viii. p. 328. *Opt. &c.*

THURINGIA. O. Lüdecke. Zs. K. x. p. 187. *Min.*
J. Clayton. Am. J. Sc. xxix. p. 454. *Loc.*

TOPAZ. F. Wiik. Öfv. Finsk. Vet. Förh. xxvii. p. 72. *Cryst.*
A. Kenngott. N. J. 1885 (1), p. 239. *Ouro Preto.*
F. Clarke and J. Diller. Am. J. Sc. xxix. p. 378. *Stoneham.*
L. Grünhut. Zs. K. x. p. 268. *Alabaschka, Cryst.*
D. Porter. R. Soc. N. S. W. xviii. p. 77. *N. S. Wales.*
C. Friedel and J. Curie. C. R. c. p. 213. *Pyroel.*; and Bull. Soc. Min. viii. p. 16.

TOURMALINE. A. Liversidge. R. Soc. N. S. W. xviii. p. 44. *N. S. Wales.*
D. Porter. R. Soc. N. S. W. xviii. p. 76. *N. S. Wales.*

TRANSCAUCASIA. L. Janet. Ann. d. Min. vii. p. 535. *Copper Minerals.*

TRIDYMITE. G. v. Rath. Zs. K. x. p. 174. *Cryst.*; and Ber. Nied. Ges. Bonn. 1885, p. 45.

TURNERITE. v. Monazite.

TUBQUOIS. N. Koksharow. Verh. Russ. Min. Ges. xx. p. 10. *Kirgis Steppe.*
G. Moore and V. v. Zepharovich. Zs. K. x. p. 240. *Pseud. after Apatite.*

UINTAHITE. W. Blake. Eng. Min. J. xl. p. 431. *New Min. Utah.*

URANINITE. C. Rammelsberg. Ber. Ak. Berl. 1885, p. 97. *Chem.*

VANADATES. v. Lead Ores.

VANADINITE. F. Genth and G. v. Rath. Zs. K. x. p. 460. *Lake Valley*; and Proc. Am. Phil. Soc. xxii. p. 365.

WAD. M. Weibull. Min. Mitth. vii. p. 111. *Silfberg, Chem.*; and Öfv. Vet. Ak. Förh. 1884, 9, p. 17.

WEHRLITE. L. Sipöcz. Min. Mitth. vii. p. 271. *Pilsen, Chem.*

WESTMORELAND. v. Cumberland.

WOLFRAM. D. Porter. R. Soc. N. S. W. xviii. p. 80. *N. S. Wales.*
L. Sipöcz. Min. Mitth. vii. p. 270. *Felsöbanya, Chem.*

WOLLASTONITE. A. Gorgeu. Ann. Chim. Phys. iv. p. 550. *Art.*
R. Breñosa. An. Soc. Esp. Hist. Nat. xiv. p. 115. *Cryst.*
I. Vogt. Bih. Vet. Ak. Hand. ix. i. p. 27. *Art.*

XENOTIME. W. Hidden. Am. J. Sc. xxix. p. 249. *Colorado.*

XONALTITE. A. Lacroix. Bull. Soc. Min. viii. p. 342. *Opt. &c.*

ZEOLITES. C. Bodewig. Zs. K. x. p. 276. *Chem.*
A. Lacroix. C. R. ci. p. 74. *Opt.*; and Bull. Soc. Min. viii. p. 321.

ZIRCON. W. Hidden. Am. J. Sc. xxix. p. 250. *Cryst.*
E. Linnemann. Ber. Ak. Wien. xci. (2), p. 1019. *Chem.*
E. Linnemann. Ber. Ak. Wien. xcii. (2), p. 427. *Opt.*
A. Purgold. Isis. Ber. 1884, p. 25. *Renfrew.*

Digitized by Google

1883 (*continued*).

ALBERTITE.	W. Morrison. Trans. Ed. Geol. Soc. iv. p. 307. *Min.*
ALBITE.	F. Wiik. Ofv. Finsk. Vet. Förh. xxv. p. 115. *Finnland.*
ALLOPHANE.	E. Smith. Am. Chem. J. v. p. 272. *Lehigh Co. Chem.*
ANDESITE.	H. Gylling. Ofv. Finsk. Vet. Förh. xxv. p. 96. *Orijärvi.*
ANORTHITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxv. pp. 117, 122. *Finnland.*
AUGITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxv. p. 123. *Opt.*
BISMUTH ORES.	J. Robertson. Trans. Geol. Soc. Glasg. vii. p. 126. *Australia.*
BLENDE.	v. Oest. Zts. B. H. xxxi. p. 57. *Contain Mercury.*
BRUCITE.	J. Schoenfeld and E. Smith. Am. Chem. J. v. p. 281. *Berks Co. Chem.*
CASSITERITE.	W. Blake. Eng. Min. J. xxxvi. pp. 144, 344. *Dakota.*
CHLOROPAL.	E. Smith. Am. Chem. J. v. p. 277. *Lehigh Co. Chem.*
COLUMBATES.	v. Samarskite.
CORUNDUM.	E. Smith. Am. Chem. J. v. p. 275. *Lehigh Co. Chem.*
CRYOLITE.	Johnstrup. Förh. Skand. Nat. Stock. 1880, p. 234. *Greenland.*
CRYSTALS.	R. Glazebrook. Proc. Camb. Phil. Soc. iv. p. 299. *Opt.*
CUMBERLAND, &c.	J. Goodchild. Trans. Cumb. Ass. viii. pp, 189, 214. *Min. of.*
DEWEYLITE.	D. Brunner and E. Smith. Am. Chem. J. v. p. 280. *Berks Co. Chem.*
DIAMOND.	W. Huddleston. Proc. Geol. Ass. viii. p. 65. *S. Africa, Min.*
FELSPARS.	F. Wiik. Ofv. Finsk. Vet. Förh. xxv. p. 115. *Finnland.*
FLUOR.	E. Smith. Am. Chem. J. v. p. 272. *Lehigh Co. Chem.*
GARNET.	E. Smith. Am. Chem. J. v. p. 276. *Lehigh Co. Chem.*
GOLD.	A. Schaeffer. Eng. Min. J. xxxvi. p. 34. *Texas.*
GOLD AND SILVER.	v. Oest. Zts. B. H. xxxi. p. 97. *Grafenau.*
HORNBLENDE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxv. p. 123. *Opt.*
IDOCRASE.	D. Brunner and E. Smith. Am. Chem. J. v. p. 280. *Berks Co. Chem.*
ITALY.	C. Ernst. Oest. Zts. B. H. xxxi. pp. 9, &c. *Min.*
LEPOLITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxv. p. 120. *Finnland.*
LIGNITE.	O. Hehner. Anal. viii. p. 133. *New Zealand, Chem.*
MELANOPHLOGITE.	G. Spezia. Att. Ac. Linc. (Mem.) xv. p. 300.
MICROCLASE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxv. p. 108. *St. Gotthard.*
MINERALS.	Dieulafait. Rev. Sci. v. p. 609. *Origin of.*
PENNSYLVANIA.	D. Brunner and E. Smith. Am. Chem. J. v. p. 279. *Min. of.*
	E. Smith. Am. Chem. J. v. p. 272. *Min. of.*
PETROLEUM.	A. Okulus. Oest. Zts. B. H. xxxi. p. 485. *Hungary.*
PYROLUSITE.	E. Smith. Am. Chem. J. v. p. 277. *Lehigh Co. Chem.*
SAMARSKITE, &c.	J. Smith. Am. Chem. J. v. pp. 44, 73. *Chem.*
SILVER.	v. Oest. Zts. B. H. xxxi. p. 471. *Finnland.*
SPHENE.	D. Brunner and E. Smith. Am. Chem. J. v. p. 280. *Berks Co. Chem.*
STASSFURT.	C. Hake. J. Soc. Chem. Ind. xi. p. 146. *Min. of.*
STILBITE.	E. Smith. Am. Chem. J. v. p. 277. *Lehigh Co. Chem.*
	D. Brunner and E. Smith. Am. Chem. J. v. p. 279. *Berks Co. Chem.*
SULPHUR.	J. Russell. Eng. Min. J. xxxv. p. 31. *Utah, Nevada.*

Digitized by Google

TENORITE.	T. Egleston. Eng. Min. J. xxxv. p. 19. *Chem.*
TIN ORES.	J. Robertson. Trans. Geol. Soc. Glasg. vii. p. 126. *Australia.*
TOURMALINE.	E. Smith. Am. Chem. J. v. p. 275. *Lehigh Co. Chem.*
WAVELLITE.	E. Smith. Am. Chem. J. v. p. 273. *Lehigh Co. Chem.*
WESTMORELAND.	v. Cumberland.
ZIRCON.	E. Smith. Am. Chem. J. v. p. 273. *Lehigh Co. Chem.*

1884 (*continued*).

ALBITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvi. p. 141. *Pyttərlaks, Chem.*
ALUMINIC SULPHATE.	W. Brown. Am. Chem. J. vi. p. 97. *Tennessee. New Min.*
AMBER.	C. Zincken. Oest. Zts. B. H. xxxii. pp. 171, 191. *Austria, &c.*
ANDESITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvi. p. 143. *Aveskutan.*
ANORTHITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvi. p. 146. *Martensby.*
ANTHRACITE.	C. Ashburner. Eng. Min. J. xxxvii. pp. 119, 143. *Pennsylvania.*
APATITE.	W. Dawkins. Trans. Man. Geol. Soc. xviii. p. 47. *Ottawa.*
APOPHYLLITE.	E. Knerr and J. Schoenfeld. Am. Chem. J. vi. p. 413. *Chester Co. Chem.*
AUGITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvi. p. 147. *Opt. Chem.*
BARYTES.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvi. p. 112. *Cryst.*
BREADALBANE.	J. Wilson and H. Cadell. Proc. Phys. Soc. Ed. cxiii. p. 189. *Min.*
BRUCITE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvi. p. 154. *Ithis, Chem.*
CASSITERITE.	W. Brown. Am. Chem. J. vi. p. 185. *Rockbridge Co.*
CELESTITE.	R. Panebianco. Att. Soc. Ven. Pad. ix. p. 142. *Padua, &c.*
CHALCHIHUITES.	C. Fernandes. Naturaleza, vi. p. 303. *Min.*
CHROMITE.	J. Wilson and H. Cadell. Proc. Phys. Soc. Ed. cxiii. p. 201. *Breadalbane.*
COLUMBITE.	W. Blake. Eng. Min. J. xxxviii. pp. 362, 376. *Dakota.*
CRYSTALLOGRAPHY.	O. Liebe. Ber. Nat. Ges. Chem. 1884, p. 152.
CRYSTALS.	C. Spurge. Proc. Camb. Phil. Soc. v. p. 74. *Opt.*
DIAMOND.	C. Friedel. Bull. Soc. Chim. xli. p. 100. *Combustion.*
	H. Roscoe. Proc. Lit. Phil. Soc. Manch. xxiii. p. 5. *Min. Chem.*
ERYTHRITE.	S. Przybitek. J. Soc. Phys. Chem. Russ. xvi. p. 367. *Chem.*
GLAUCONITE.	E. Knerr and J. Schoenfeld. Am. Chem. J. vi. p. 412. *Chester Co.*
GOLD.	W. Courtis. Eng. Min. J. xxxvii. p. 478. *Montana.*
GRAPHITE.	H. Jüptner. Oest. Zts. B. H. xxxii. p. 593. *Chem.*
HAYDENITE.	H. Morse and W. Bayley. Am. Chem. J. vi. p. 24. *Chem.*
HEULANDITE.	E. Knerr and J. Schoenfeld. Am. Chem. J. vi. p. 413. *Lancaster Co.*
HORNBLENDE.	F. Wiik. Öfv. Finsk. Vet. Förh. xxvi. p. 147. *Opt. Chem.*
IRON ORES.	A. Julien. Eng. Min. J. xxxvii. p. 81. *Origin of.*

Digitized by Google

MENACCANITE.	E. Knerr and D. Brunner. Am. Chem. J. vi. p. 413. *Lancaster Co.*
MINERALS.	J. Judd. Proc. Geol. Ass. viii. p. 278. *Spec. Grav.*
MINERAL VEINS.	F. Sandberger. Eng. Min. J. xxxvii. pp. 196, 218, 232. *Origin of.*
	M. Wadsworth. Eng. Min. J. xxxvii. p. 364. *Origin of.*
NEPHRITE.	H. Traube. Leop. xx. p. 76. *Jordansmühl.*
NEW MINERALS.	v. Aluminic Sulphate, Ramisite.
ORES.	J. Newberry. Eng. Min. J. xxxviii. p. 38. *Origin of.*
OZOCERITE.	F. Smith. Am. Chem. J. vi. p. 247. *New Jersey.*
PECTOLITE.	E. Smith. Am. Chem. J. vi. p. 411. *Lehigh Co. Chem.*
QUARTZ.	M. Woulff. J. Soc. Phys. Chem. Russ. xvi. p. 140. *Elect.*
RAMISITE.	M. de Leon. Naturaleza, vii. p. 65. *New Min. Potosi.*
SPHENE.	E. Smith. Am. Chem. J. vi. p. 412. *Lehigh Co. Chem.*
STILBITE.	W. Hoskisson and D. Brunner. Am. Chem. J. vi. p. 414. *Berks Co.*
	F. Davidson. Am. Chem. J. vi. p. 414. *Berks Co. Chem.*
STRONTIANITE.	H. Jüptner. Oest. Zts. B. H. xxxii. p. 594. *Neubery, Chem.*
SULPHUR.	Maquenne. Bull. Soc. Chim. xli. p. 238. *Cryst.*
TANTALITE.	C. Schaeffer. Eng. Min. J. xxxviii. p. 285. *Dakota.*

Digitized by Google

LIST OF ABBREVIATIONS USED IN INDEX.

See also Vol. vi. pp. 142, 187, 232.

Am. Chem. J.	American Chemical Journal (Remsen). Baltimore.
Anal.	The Analyst. London.
Ant. Mad. Mag.	The Antananarivo Annual and Madagascar Magazine. Antananarivo.
Arch.Liv.Ehst.Kurl.	Archiv für die Naturkunde Liv-Ehst-und Kurlands. Dorpat.
Att. Ac. Pal.	Atti della reale Accademia di Scienze, Lettere e belle Arti di Palermo. Palermo.
Att. Soc. Ven. Pad.	Atti della Società Veneto-Trentina di Scienze naturali residente in Padova. Padova.
Att. Un. Gen.	Atti della R. Università di Genova. Genova.
Ber. Nat. Ges. Chem.	Bericht der naturwissenschaftlichen Gesellschaft zu Chemnitz. Chemnitz.
Ber. Nat. Ges. Freib.	Berichte über die Verhandlungen der naturforschenden Gesellschaft zu Freiburg i. B. Freiburg.
Ber. Nat. Ges. St. Gall.	Bericht über die Thätigkeit der St. Gallischen naturwissenschaftlichen Gesellschaft. St. Gallen.
Ber. Nat. Ver. Aug.	Bericht des naturhistorischen Vereins in Augsburg.
Ber. Nat. Ver. Pass.	Bericht des naturhistorischen Vereins in Passau.
Boll. Sci. Pav.	Bolletino Scientifico. Pavia.
Bull. Inst. Gen.	Bulletin de l'Institut National Genevois. Geneva.
Bull. Soc. Belg. Mic.	Bulletin de la Société Belge de Microscope. Bruxelles.
Bull. Soc. Chim.	Bulletin de la Société Chimique de Paris. Paris.
Bull. Soc. Murith.	Bulletin de la Société Murithienne de Valais. Neuchatel.
Bull. Soc. Nat. Colm.	Bulletin de la Société d'Histoire Naturelle de Colmar.
Bull. Soc. Neuch.	Bulletin de la Société des Sciences Naturelles de Neuchatel. Neuchatel.
Bull. Soc. Vaud.	Bulletin de la Société Vaudoise des Sciences Naturelles. Lausanne.
Can. Rec.	The Canadian Record of Science. Montreal.
Förh. Skand. Nat. Stock.	Förhandlingar vid de Skandinaviska Naturforskarnes. Stockholm.
G. Soc. Pal.	Giornale di Scienze Naturali ed Economiche pubblicato per cura della Società di Scienze di Palermo.
Jahrb. Ak. Erf.	Jahrbücher der k. Akademie gemeinnütziger Wissenschaften zu Erfurt.

Digitized by Google

JAHRB. B. H. SÄCHS.	Jahrbuch für das Berg-und Huttenwesen im Königreiche Sachsen. Freiberg.
JAHRB. PREUSS. LANDESANS.	Jahrbuch der k. preussischen geologischen Landesanstalt und Bergakademie. Berlin.
JAHRESB. NAT. GES. GRAUB.	Jahresbericht der naturforschenden Gesellschaft Graubündens. Chur.
J. AM. CHEM. SOC.	Journal of the American Chemical Society. New York.
J. R. AS. SOC. BOMB.	Journal of the Bombay Branch of the Royal Asiatic Society. Bombay.
J. R. AS. SOC. CEYL.	Journal of the Ceylon Branch of the Royal Asiatic Society. Colombo.
J. R. AS. SOC. CHINA.	Journal of the China Branch of the Royal Asiatic Society. Shanghai.
J. SOC. CHEM. IND.	Journal of the Society of Chemical Industry. Manchester.
J. SOC. PHYS. CHIM. RUSS.	Journal de la Société physico-chimique Russe. St. Petersburg.
LEOP.	Leopoldina. Halle.
MEM. AC. BARC.	Memorias de la real Academia de Ciencias naturaes y Artes de Barcelona. Barcelona.
MEM. IST. VEN.	Memorie del reale Istituto Veneto di Scienze, Lettere ed Arti. Venezia.
MEM. SOC. PHYS. GEN.	Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Geneva.
MID. NAT.	The Midland Naturalist. Birmingham.
MITTH. NAT. VER. NEU-POMM.	Mittheilungen aus dem naturwissenschaftlichen Vereine von Neu-Vorpommern und Rügen. Greifswald.
MIN. J.	The Mining Journal. London.
NAT. SIC.	Il Naturalista Siciliano. Palermo.
NATURALEZA.	La Naturaleza. Mexico.
NUOV. SAGG. AC. PAD.	Nuovi Saggi della R. Accademia di Scienze, Lettere ed Arti. Padova.
OEST. ZTS. B. H.	Oesterreichische Zeitschrift für Berg-und Huttenwesen. Wien.
ÖFV. FINSK. VET. FÖRH.	Öfversigt af Finska Vetenskaps-Societetens Förhandlingar. Helsingfors.
PROC. AM. AC.	Proceedings of the American Academy of Arts and Sciences. Boston.
PROC. GEOL. ASS.	Proceedings of the Geologists' Association. London.
PROC. PHIL. SOC. BIRM.	Proceedings of the Birmingham Philosophical Society. Birmingham.
PROC. PHYS. SOC. ED.	Proceedings of the Royal Physical Society. Edinburgh.
PROC. U. S. NAT. MUS.	Proceedings of the United States National Museum. Washington.
Q. J. GEOL. SOC.	Quarterly Journal of the Geological Society of London (and Proceedings). London.

Digitized by Google

Riv. Ac. Pad.	Rivista Periodica dei Lavori della Regia Accademia di Scienze, Lettere ed Arti. Padova.
R. Soc. Tasm.	Papers and Proceedings of the Royal Society of Tasmania. Tasmania.
Trans. As. Soc. Jap.	Transactions of the Asiatic Society of Japan. Yokohama.
Trans. Conn. Ac.	Transactions of the Connecticut Academy of Arts & Sciences. New Haven.
Trans. Cumb. Ass.	Transactions of the Cumberland & Westmoreland Association. Carlisle.
Trans. Ed. Geol. Soc.	Transactions of the Edinburgh Geological Society. Edinburgh.
Trans. Geol. Soc. Glasg.	Transactions of the Geological Society of Glasgow. Glasgow.
Trans. Irish Ac.	Transactions of the Royal Irish Academy. Dublin.
Trans. Man. Geol. Soc.	Transactions of the Manchester Geological Society. Manchester.
Trans. S. Afr. Phil. Soc.	Transactions of the S. African Philosophical Society. Cape Town.
Trud. Obsh. Est.	Trudui obshehestra Estestvoispuitatelei. Kazan.
Trud. St. Pet. Obsh. Est.	Trudui St. Petersburg obshehestra Estestvoispuitatelei. St. Petersburg.
Verh. Nat. Ver. Heid.	Verhandlungen des naturhistorischen-medicinischen Vereins zu Heidelberg.

Digitized by Google

Abstracts.

Struvite from Homburg.—E. Kalkowsky (*Zeits. f. Krystallographie*, XI. p. 1). The crystals are somewhat different in habit from those of other localities; they are here made the subject of thermo-electrical experiments, with the method devised by Prof. Kundt (*Wied. Ann.* Vol. XX.), which has already been successfully applied to quartz and boracite; in this method, as is now well-known, the crystals while cooling are dusted with a mixture of fine sulphur and red lead, which dispose themselves respectively on the antilogous and analogous poles. In the case of Struvite, it is found that the basal plane sometimes occurs at the analogous and sometimes at the antilogous end, and the same is true of the dome planes; the Homburg crystals taper towards the antilogous pole and have the basal plane at the analogous end. H. A. M.

Göthite.—E. Palla (*Ibid.* p. 28) describes a particularly well-developed Cornish crystal in which the angles could be accurately measured; the pyramid faces are slightly displaced from the positions which they should occupy on the assumption that the system is orthorhombic, and can only be referred to forms having simple indices if the crystals be regarded as belonging to the oblique system and twinned about the ortho-pinacoid; the axial angle in this case would be 90°36¼′. The optical properties closely resemble those of Brookite, the mineral being almost uniaxial for red, and having an axial angle of about 50° for blue and green light. It is not certain, therefore, whether it is to be referred to the oblique system or to the orthorhombic with vicinal planes replacing the principal pyramid planes. H. A. M.

Adularia.—A. Cathrein (*Ibid.* p. 113) describes and figures adularia from St. Gotthard with the new face $(\bar{5}06)\ \frac{5}{6}\,P\infty$; from San Piero, Elba, with the new form $(\overline{12} : 10 : 1)\ 12\,P\,\frac{6}{5}$; and from Schwarzenstein, Zillerthal, with the face (201) —2 P∞ which had been registered by previous observers, but rejected after careful criticism by Hessenberg. H. A. M.

P. Jannasch (*Neues Jahrbuch*, 1885 (1), p. 93), from a careful estimation of the proportion of water in clinochlore from the Mussa Alp, finds that the mineral contains 5 molecules of water and not 4 as has been hitherto supposed; of these, one molecule may be regarded as water of crystallisation, being given off over concentrated sulphuric acid at ordinary

Digitized by Google

temperatures, while the remaining 4 molecules are only lost at red heat. The composition may be represented by the formula:—4 H_2O, 5 MgO, Al_2O_3, 3 SiO_2, H_2O. H. A. M.

F. Sandberger (*Ibidem*, p. 171) finds that a number of micas contain a small and varying percentage of boric acid, although entirely free from Tourmaline microlites. The author also describes apatite occurring in pegmatite from Zwiesel which contains 3 per cent. of oxide of manganese. The name Leuco-manganite, which was given by him in 1879 to a phosphate of manganese from Rabenstein, is now withdrawn, since the mineral is found to be identical with Fairfieldite. H. A. M.

A. Kenngott (*Ibidem*, p. 241) points out that the calcium borates known under the name of Priceite, Colemanite, and Pandermite, are in all probability identical, and may be represented by the formula 4CaO, 5 B_2O_3 with a varying proportion of water. H. A. M.

A new mineral is described by Whitman Cross and L. G. Eakins under the name Ptilolite (from πτίλον, *down*) in the *American Journal of Science*, Vol. XXXII. p. 117. This mineral occurs as white tufts resembling Mesolite in the pores of a vesicular Augite-Andesite, which is found in fragments in the conglomerate beds of tertiary age at Green and Table Mountains, Jefferson Co., Colorado. The tufts of Ptilolite lie on a thin coating of chalcedony which lines the pores of this rock. The composition is represented by the formula (Ca K_2 Na_2) O, Al_2O_3, 10 SiO_2, 5 H_2O, so that the mineral is more nearly allied to Stilbite than to anything else, but contains a higher percentage of silica than any known hydrated alumino-silicate. Ptilolite is gradually decomposed by strong sulphuric acid, and before the blowpipe fuses to a clear glass; under the microscope it is seen to consist of transparent hair-like prisms of which the extinction in polarised light is parallel to their axis. H. A. M.

E. S. Dana (*American Journal of Science*, XXXII. p. 314) gives a number of figures and a description of the crystals of Brookite (*Arkansite*) from Magnet Cove; these figures illustrate the striking variety of form exhibited by the Rutile from a single locality, and add a new prism face to those already observed. H. A. M.

The occurrence of Topaz and Garnet in Lithophyses of Rhyolite is described by Whitman Cross (*American Journal of Science*, XXXI. p. 432). Minute crystals of these minerals are developed in the vesicles (*Lithophyses*) of a Rhyolite at Nathrop, Colorado, and also at Chalk Mountain, Colorado, and at a point 40m. N. of Sevier Lake, Utah. The outer walls of the Lithophyses are formed of Sanidine, and with the Garnets and

Digitized by Google

Topaz which occur within them are associated minute crystals of quartz. A similar occurrence of Fayalite, from the National Yellowstone Park, was described by Iddings, so that quartz, Tridymite, Sanidine, Biotite, Augite, Topaz, Garnet, and Fayalite are the minerals now known to occur in this manner. H. A. M.

Max Bauer (*Neues Jahrbuch*, 1886 (1), p. 62) describes the pseudomorphs of Calcite after Aragonite, found at Klein-Sachsenheim in Wurtemberg. The crystals (sometimes 10 cm. long and 5 cm. thick) are deposited abundantly in large lenticular cavities in the yellow-red dolomite of the "Lettenkohle," associated with chalybite and nodules of gypsum.

The occurrence is very similar to that of pseudomorphs of Aragonite described by Sandberger from Oberwern.

The author considers that the cavities were originally filled with gypsum which had been deposited as a band in the dolomite, but of which only a trace now remains, and that as the gypsum was dissolved, crystals of Aragonite were deposited; for it appears, from Credner's researches, that the presence of gypsum in a calcareous solution may cause the carbonate to crystallise as Aragonite and not as Calcite.

It was impossible to determine with exactness the crystallographic form of the Wurtemberg crystals on account of the roughness of their faces, but they are similar to the hexagonal forms of Herrengrund, Leogang, &c.

A section of a portion of fresh limpid Aragonite cut perpendicular to the prism is seen to consist of three individuals, this treble twin-aggregation being characteristic of all the crystals. One pair of crystals seemed to be a twin about the plane $\frac{1}{3}\breve{P}\infty$ (013), so far as it could be determined by means of a paper model and a hand goniometer; but this single observation scarcely establishes a new twin law for this mineral.

The Aragonite is quite fresh in some of the crystals, whilst in others little or no trace of this species is found though the form is retained: they generally consist of Calcite surrounding a kernel of Aragonite, clearly showing that the alteration has taken place from the outside; and there are always traces of a crust of chalybite upon the crystals whether they are altered or fresh. The author considers that the band of gypsum was decomposed by water containing carbonic acid, resulting in crystals of Aragonite being formed; a thin layer of brown-spar was then deposited upon the sides of the cavities and the faces of the Aragonite crystals. When this layer had entirely coated the crystals, little or no water had entered into them, they remaining perfectly transparent and fresh; but when the protecting shell had not been so perfect, the water in the druses had dissolved away the Aragonite. The solution of carbonate of lime

Digitized by Google

being saturated, and no longer containing gypsum, was now favourable for the production of Calcite, which might further be induced by the presence of the isomorphous chalybite. The solution being in contact with the Aragonite would remain saturated, so that its decomposition would continually accompany the deposition of the Calcite.

The author considers that many so-called paramorphs may have originated in a similar way. B. H. S.

The Optical Characters of Pyroxene (*Neues Jahrbuch*, 1885 (1), p. 43). C. Doelter endeavours to trace the relation between the proportion of iron and the extinction angle in the plane of symmetry which was first indicated by Tschermak; with this object he gives the analyses and extinction angles of 22 varieties of pyroxene. From these it appears that the extinction angle increases regularly, not with the percentage of iron-oxide nor of iron oxide and alumina, but with the proportion of the iron and alumina silicates which enter into the composition of the pyroxene; in other words, the angle diminishes regularly as the proportion of the remaining silicate $CaMgSi_2O_6$ increases. Taking as abscissæ the percentage of all the silicates $CaFeSi_2O_6$, $MgFe_2SiO_6$, $MgAl_2SiO_6$, $Na_2Al_2SiO_6$, and as ordinates the extinction angle, a regular curve is obtained, whereas if the percentages of either FeO, Fe_2O_3, Al_2O_3, or all three together, are taken as abscissæ, the curve is irregular. The author finds that the curve for Diopside does not coincide with that for the alumina-augites.

H. A. M.

A New Variety of Kobellite.—(*Neues Jahrbuch*, 1886 (1), p. 79). A new sulpho-bismuthite of lead and silver is described by H. F. and H. A. Keller, from Leadville, Colorado. It is a steel-grey crystalline mineral, of metallic lustre, and with dark green to black streak, which occurs in nodules mixed with galena. Analyses lead to the formula 3 (Pb Ag_2) S, Bi_2S_3, the percentage of silver being between 5 and 6. H. A. M.

Digitized by Google

Review.

Lehrbuch der Mineralogie.

By Max Bauer (Berlin and Leipzig, 1886).

This excellent manual is intended for use either as a class text-book or as a guide to private study, and is admirably adapted for these purposes. While it does not aim at the fulness of detail which renders the Lehrbuch of Naumann (now edited by Prof. Zirkel) so convenient as a book of reference, it contains a large amount of information in a very readable form, and is thoroughly up to date.

As might be expected, the subjects of Crystallography and Physical Mineralogy are most fully treated; but it is unfortunate that the chemistry of the science does not receive its fair share of attention. About half of the book is devoted to the general introduction and the remainder to the description of mineral species, so that the latter occupies a smaller part of the work than is usual in text-books. In the first half crystallography and physics extend over 208 pages, while 35 pages are considered enough for mineral chemistry, including the origin and association of minerals. The optical characters (interference figures, &c.) are admirably treated, and the description of twin growth, while far from satisfactory, is more detailed than is usual.

In the second half of the book the less important minerals are only briefly described, and are distinguished from the more important by the use of a small type.

There are many good points in the book: the figures, which are for the most part new, are excellent; frequent references are given to important papers, even those of very recent date; there is a good bibliography; and the modes of occurrence and origin of minerals are ably discussed.

In the introductory portion the object of the author has been to describe all that is of practical importance without entering into theoretical considerations, and only those points which are illustrated by mineral substances are considered at any length.

As regards the descriptive portion, exception may be taken by many readers to the classification adopted, which is somewhat unusual (Borates, Carbonates, Titanates, Silicates, Tantalates, Phosphates, Wolframates, Chromates, Sulphates); while within each class an attempt is made to

Digitized by Google

arrange the species in the order of increasing basicity, the hydrated compounds being separated from the anhydrous. In this part of the book, as in the introduction, the chemical properties do not receive the attention which they deserve.

We notice that in the list of minerals, which professes to be complete, Connellite is conspicuous by its absence, as indeed is the case in almost all German text-books; Astrophyllite is retained with the mica group, though now generally regarded as a Pyroxene; such small points, and the many misprints which unfortunately disfigure the book, will, it may be hoped, be corrected in a second edition, which will doubtless be soon required. The book is an excellent manual, and may be heartily recommended.

Digitized by Google

Digitized by Google

THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

No. 34. JULY 1887. Vol. VII.

On a Meteoric Iron found in 1884 in the Sub-district of Youndegin, Western Australia, and containing Cliftonite, a cubic form of Graphitic Carbon.

By L. Fletcher, M.A., F.C.S., President.

[Read January 11th, 1887.]

THIS iron was found on January 5th, 1884, by Alfred Eaton, a mounted police constable, when on duty in the sub-district of Youndegin, at a spot distant about 60 chains (three-quarters of a mile) in a north-west direction from the top of Penkarring Rock, and roughly estimated by him as 70 miles east of York, Western Australia; this must be about longitude 117°30′ E. of Greenwich, latitude 31°30′ S. Only one of four observed fragments having been brought in by Mr. Eaton, the late Captain Smith, Commissioner of the Police at Perth, sent him out to Penkarring with a native assistant with instructions to bring in the other three, at the instance of the Rev. Charles G. Nicolay, Curator of the Geological Museum, Fremantle, to whom the late Mr. Edward T. Hardman, F.C.S., the Government Geologist, had expressed his belief in the meteoric origin of the iron. Eaton and his companion started off on horseback at 8 a.m. on February 28th, encamped at a "rock hole" for the night, and leaving at 6 a.m. the next day reached Penkarring at 7.30 a.m. An unsuccessful search was

Digitized by Google

made for fragments additional to those already observed. Leaving Penkarring at 7 a.m. on 1st March, they encamped at Morecanning for the night, and arrived at York Police-station at 7 o'clock on the following morning.

To the zeal and thoughtfulness of Mr. Nicolay we are indebted for the preservation of the specimens, and for the particulars of their discovery: by him, at the suggestion of Lady Barker, the largest and the smallest fragments have been generously presented to the British Museum through Mr. R. H. Scott, F.R.S., as Secretary of the Mineralogical Society.

The four fragments were lying loose on the surface, three of them close together, and the fourth about 15 ft. away: they weighed 25¾ lbs., 24 lbs., 17½ lbs. and 6 lbs., respectively: in the opinion of Mr. Nicolay they seem to have formed a portion of a spherical mass, although they are individually irregular in shape. Scattered around the iron there were broken pieces, apparently belonging to a shell or outer covering, and of these a weight of 17 lbs. was collected. As the latter fragments consist essentially of magnetic oxide of iron, they are doubtless due to the action of the weather on the meteorite: the samples sent to the Museum have a laminated structure, and one of them is an inch in thickness.

The country around Youndegin is described as granitic with dykes of quartz, and schistose rocks: there is a superficial covering of sandstone, in which, though widely distributed over the Colony, no fossils have yet been found: there is no appearance of iron ore at Youndegin, though in many parts of the Colony iron ores are found in abundance. The above circumstances indicate an extra-terrestrial origin for the iron.

The only meteoric iron previously discovered in Australia is that of Cranbourne, near Melbourne, 1,500 miles distant from Youndegin.

The largest of the two fragments presented to the British Museum weighed 25¾ lbs.: it is 12 inches long, 10 inches broad, and has a maximum thickness of 3 inches. In shape it is rudely convex at one side and concave at the other; its surface presents numerous spherical depressions. It is distinguished from all the meteoric irons in the British Museum collection by two cylindrical holes, completely traversing the iron from back to front: one of them has a diameter varying from 2 to 2¼ inches, and a length of 1½ inches; the other is of nearly the same size: three similar annular openings characterise the iron of Tazewell, Claiborne County, Tennessee, U.S.A., described and figured by the late Professor Lawrence Smith.[1] The large Signet iron, preserved in the National Museum at

[1] *Amer. Journ. Sc.* 1855, Ser. 2, Vol. 19, p. 154.

Digitized by Google

Washington, is an almost complete ring[1]: the meteoric iron of Independence County, described lately by Mr. Hidden,[2] is likewise remarkable for the presence of a small hole.

The smallest fragment of the Youndegin iron, weighing 6 lbs., also in the British Museum, is likewise concavo-convex, but is without holes: it is 7 inches long, 4½ inches broad, and about 2 inches thick.

The fragment weighing 24 lbs. is similar to the last mentioned; it is 9¾ inches long, 6 inches broad, and 4 inches thick: it is to be preserved in the Geological Museum, Fremantle.

The remaining fragment weighing 17¼ lbs. has been presented to the Melbourne Museum, Victoria.

The specific gravity was determined from three small pieces of the larger fragment, freed from rust; the numbers obtained were 7·86, 7·85, and 7·72 respectively.

The large specimen was cut on the premises of the Museum by means of hack-saws, and was found to be so hard that three weeks were required for the severance of a fragment of which the cut face is not 2½ inches square: a larger section of another meteoric iron (Nejed) was made in one-third of this time. The surface was next worked down with hard files of increasing fineness, and lastly polished with felt and emery powder.

On this face are seen numerous sections of enclosures, mostly tabular, of a yellowish metallic mineral which is strongly attracted by a magnet: this was found to be schreibersite (phosphide of iron and nickel): some of the enclosures are in parallelism, and parts, isolated on the surface of the iron, are lineally arranged: the edges of the plates are only approximately straight: starting from them, thin cracks containing Schreibersite traverse the surface of the section in irregular directions: one of the plates is an inch long and one-eighth of an inch thick.

No stony matter is visible on the polished surface.

Relative to copper sulphate the iron is almost immediately active.

After exposure to the action of bromine water or dilute nitric acid the section gives no definite figures, but assumes a damascene appearance, very like that of the Tucuman iron, and of some parts of that of Brazos: to the latter iron it is very similar in the proportion and distribution of the Schreibersite: the British Museum sections of the Arva and Sarepta irons are also, in parts, somewhat similar to it in their general characters.

On warming a fragment, weighing 7 grams, in dilute hydrochloric acid,

---

[1] Ibid. p. 161.

[2] *School of Mines Quarterly*, Vol. 7, No. 2, Jan. 1886.

Digitized by Google

the greater part dissolved, and there was left a small residue (56 milligrams) of yellowish metallic scales which are very strongly attracted by a magnet and contain phosphorus: they are doubtless Schreibersite, and identical with the enclosures visible on the polished surface.

None of the cubic cystals, described below, were present in this residue.

No sulphuretted hydrogen was detected in the gas evolved during the solution of the iron; this indicates the absence of troilite from the fragment under examination.

The sulphur precipitated on passing sulphuretted hydrogen into the solution was faintly brown: the colouration was found to be due to traces of copper, the constancy of which as an ingredient of meteoric iron has been insisted upon by Lawrence Smith.

Besides iron, only nickel, cobalt and magnesium, were found in the solution.

As the iron was too hard for its filings to be used as material for quantitative analysis, a large fragment, containing visible Schreibersite, was filed until free from rust: its weight was 8·3200 grams: its specific gravity, at 14°·5 C., relative to water at 4° and allowing for displaced air, was 7·851 (uncorrected 7·86).

The fragment was dissolved in aqua regia in a porcelain dish, and evaporated to dryness, on the water-bath: the residue was treated with strong hydrochloric acid, and again brought to dryness to expel the remaining traces of nitric acid: on warming with water containing some hydrochloric acid, it was found that there was a small insoluble residue, consisting wholly of minute bright opaque greyish-black cubic crystals with metallic lustre. The solution itself was poured into a weighed double filter,[1] and the crystals were washed by decantation, the washings being passed through the double filter: the filter showed no change of weight. The weight of the crystals was found to be 3·1 milligrams.

The filtrate was made up to 1,000 cc., and portions, 125 cc. each, were removed by means of pipettes.

In one portion sulphuric acid was sought for, but not a trace was found, indicating the absence of troilite from this fragment also.

Another portion was evaporated to dryness on the water-bath, and afterwards heated in an air-bath for three quarters of an hour, at a temperature of 140°—145° C.: no silica was obtained. The phosphoric acid in this portion was next concentrated in the manner recommended by

[1] *Original Researches*, by Lawrence Smith, 1884, p. 312.

Digitized by Google

Lawrence Smith,[1] precipitated as phospho-molybdate,[2] dissolved in ammonia, and weighed as magnesium pyrophosphate.

From a third portion the iron was separated by a double precipitation with sodium acetate, redissolved in hydrochloric acid, and reprecipitated with ammonia.[3] After ignition it was reduced by heating in a current of hydrogen, and dissolved in dilute hydrochloric acid: in experiments on different portions variable minute quantities of silica were at this point obtained, and were derived probably from the re-agents.

The nickel and cobalt were separated from the magnesium by ammonium sulphide, and weighed together both in the oxidised and metallic condition: after solution of the nickel and cobalt the latter was precipitated by potassium nitrite, and weighed as potassium cobalt sulphate.

In this way the composition of the iron was found to be as follows:—

Iron	92·67
Nickel	6·46
Cobalt	0·55
Copper	trace
Magnesium	0·42
Phosphorus...	0·24
Sulphur	none
Insoluble cubes	0·04
Total	100·38

If the phosphorus be assumed to be wholly present in combination with iron and nickel, as Schreibersite, with the formula Fe_3 Ni P and percentage composition Iron 55·53, Nickel 29·09, Phosphorus 15·38, the above will correspond to:—

Nickel-iron	98·82
Schreibersite	1·56
	100·38

As no opaque greyish-black mineral with a metallic lustre, and insoluble in aqua regia, is recognised as occurring in cubic crystals, the satisfactory determination of the nature of the insoluble residue of 3·1 milligrams was expected to be a matter of some difficulty: further, two fragments of the iron, weighing 7 grams and 2 grams respectively, had not yielded a single crystal, and there was thus a possibility of the crystals being so localised as to render impracticable an increase of the quantity of material available for experiment.

[1] *Amer. Jour. Sc.* 1882, Ser. 3, Vol. 23, p. 316.

[2] *Select Methods in Chemical Analysis*, by Crookes: 2nd edition, p. 517.

[3] *Ibid.* p. 272.

Digitized by Google

The crystals were about a hundred in number, the average thickness of the larger ones being one-fourth of a millimeter (one-hundredth of an inch).

On all the crystals the faces of the cube are predominant: many are sharply defined simple cubes; some have their edges truncated by faces of the dodecahedron, as was proved by measurement on the goniometer; in others the edges are replaced by rounded faces of a tetrakis-hexahedron; or again, one or more of the cube-faces is replaced by a very obtuse, almost flat, square pyramid. One of the cubes shows re-entrant edges, suggesting a lamellar growth. A little group of three parallel crystals was observed.

One of the crystals having been dropped on to a thin layer of red sealing wax melted on a glass plate, was held sufficiently firmly by the cooled wax to allow of its hardness and streak being determined. The hardness is greater than that of rock-salt, and less than that of calcite: it may be expressed as 2·5. The streak on white unglazed porcelain is black and shining.

The crystals are not affected by a magnet.

Of four crystals, two sank to the bottom, and two floated near the surface of a solution of specific gravity 2·12.

The crystals remain unaltered when heated in a glass tube, closed at one end.

They are unattacked by nitro-hydrochloric, sulphuric, or hydrofluoric acids.

They float unaltered in beads of borax, microcosmic salt, or sodium carbonate, held in a blowpipe flame.

On dissolving in water a bead of sodium carbonate and potassium nitrate, in which three of the crystals had been heated, only one crystal was seen, and this was much reduced in size: the solution of the bead gave no evidence of the presence of chromium.

Similar beads, in each of which a crystal had been dissolved, were tested for phosphoric and silicic acids with negative results; nor did the solution of a bead in hydrochloric acid give any precipitate with ammonia, ammonium sulphide, ammonium carbonate, or sodium phosphate.

Heated in a combustion tube in a current of oxygen, hydrogen or chlorine, they are unattacked, even when the glass begins to melt.

Heated in a long narrow porcelain crucible in air or oxygen with the table-blowpipe they appear unaltered, but in a shallow uncovered platinum capsule or small porcelain crucible they slowly disappear, without flame: from the platinum capsule the disappearance was complete, but in the

Digitized by Google

porcelain crucible there was sometimes left an almost imperceptible black residue: projecting from this, in one instance, minute fibres were seen with the microscope.

Heated with potassium nitrate in a crucible over a Bunsen burner they are unattacked, but disappear very slowly, without deflagration, when heated with the table-blowpipe.

In density, colour and streak, and in its chemical behaviour, the residual mineral thus resembles native graphite, but it is considerably harder, and presents itself in well-defined crystals which belong, like the other crystallised form of carbon, the diamond, to the cubic system: terrestrial graphite, when crystallised, is found only as tabular crystals so indistinctly formed that doubt has long existed as to whether they should be referred to the hexagonal or monosymmetric system.

From other fragments of the iron, weighing altogether about 10 grams, thirty more of the cubic crystals were obtained.

Graphitic carbon, sometimes in large nodules, has been found concreted in several meteoric irons, and has been subjected to careful examination by Lawrence Smith:[1] in structure and powder it is not unlike the compact Borrowdale graphite, and differs completely both from the scaly graphite found native and from that which is presented by certain cast irons; on the other hand, its conversion into graphitic acid by oxidising reagents is more rapid than that of any terrestrial native graphite experimented upon by him.

In a paper entitled "Graphite, pseudomorphous after Iron Pyrites," Haidinger,[2] in 1846, described some graphitic crystals which are doubtless identical in their general characters with those furnished by the Youndegin iron: his observation, however, has been forgotten, and is without record in modern meteoric literature. The crystals, of the size, number, and completeness of which Haidinger makes no mention, were obtained by him from a nodule of graphite which had dropped out of the Arva meteoric iron: impressed by the similarity in shape of the nodules of graphite and sulphide of iron present in this meteorite, and by the circumstance that the two minerals are occasionally lying side by side, Partsch conceived the idea that one was pseudomorphous after the other; and Haidinger and Partsch became convinced of the correctness of this idea by the form of the graphitic crystals, on the cube-edges of which they believed there were faces of the pentagonal dodecahedron π {120}, so common a feature of the crystals of iron pyrites. Of the incorrectness of this explanation

[1] *Amer. Jour. Sc.* 1876, Ser. 3, Vol. 11. p. 388. [2] *Pogg. Ann.* 1846, Vol. 67, p. 437.

Digitized by Google

of the graphitic crystals there can be no doubt: the presence of iron pyrites, crystallised or massive, has even yet not been established for any meteorite; the meteoric sulphide of iron being not the bisulphide but the protosulphide, and having since received from Haidinger himself the specific name of troilite (1863).

Nor is Haidinger's interpretation of the form of the Arva graphitic crystals beyond criticism, for Gustav Rose,[1] to whom the crystals had been kindly sent for inspection, expressed an opinion that the mode of replacement of the cube-edges was suggestive rather of holo-symmetry than of hemi-symmetry—an interpretation which would exclude iron pyrites as a possible antecedent mineral.

The Youndegin graphitic crystals support the view entertained by Rose: the existence of the dodecahedron-face, of which there is goniometrical proof, is of itself quite sufficient to show that the crystalline form is distinct from that of iron pyrites. The iron pyrites theory being abandoned, and the fact being recognised that no mineral constituent of meteorites has yet been found which crystallises in forms similar to those of the graphitic crystals, there naturally arises a feeling of doubt as to the correctness of the view according to which they are of pseudomorphic origin, and a question as to whether they do not represent a third allotropic condition of crystallised carbon: it is conceivable, in fact, that the explanation by pseudomorphism really resulted from the supposed similarity of the form of the crystals to that of iron pyrites.

Bischof[2] denies the possibility of explaining the pseudomorphism of terrestrial minerals by any other process than the slow action of water, of which there is no evidence in meteorites; and though it would be unsafe to argue that only in this way could meteoric pseudomorphs be produced, there is sufficient difficulty in accounting for the occurrence of pseudomorphs in the interior of a mass of iron to compel us to demand strong evidence before the pseudomorphism of the graphitic crystals is granted, more especially when we have regard to the fact that no other graphitic pseudomorph has yet been established either in meteoric or in terrestrial minerals.

The Youndegin crystals were accordingly examined under the microscope with a quarter-inch objective. One of the dodecahedron-faces, an elongated hexagon in shape, showed ridges symmetrical to the truncated edge of the cube, and parallel to the two short edges of the hexagon which meet in

[1] *Beschreibung und Eintheilung der Meteoriten*, 1864, p. 40. *Pogg. Ann.*, 1873, Vol. 148, p. 516.

[2] *Chemical and Physical Geology*, 1854, Vol. I. p. 33.

Digitized by Google

one of the trigonal quoins. From the faces of several of the crystals spring acutely conical, almost acicular, projections of the same material, more or less irregular in shape: sometimes there is an approximately spherical growth covering a greater part of a cube-face, and occasionally one of the spherical growths is broken, and is seen to be merely a thin, now empty, shell, of which the bottom is the face of the cube: in shape this is suggestive of a burst bubble. One specimen was apparently a fragment of a hollow cube.

The crystals are easily frangible; one of them, when gently pressed between a glass plate and a sheet of paper, was flattened out and was split parallel to the edges of one of the cube-faces, as if the crystal had been hollow and had collapsed. Examined under the microscope, one of the thin fragments was found to consist of several distinct layers parallel to a cube-face, and on its interior surface was seen a bright triangular face in the zone of a cube-edge: another thin square fragment, doubtless a face of the original cube, has a granulated internal surface, and its edges are bent at right angles to its plane, as if it had formed a portion of a shell. The powder of this crystal was scaly, and gave a scarcely visible streak on the paper. Three other crystals were found to be solid. No cleavage surfaces were visible on the fragments.

The crystals appear to be quite homogeneous in their material.

Although some of these characters point, more or less distinctly, to a pseudomorphic origin of the crystalline form, it cannot be said that they suffice to establish it. The easy frangibility, the absence of evidence of cleavage, the hollowness, and the occasionally crust-like structure, though such as are common in pseudomorphic minerals, are not incompatible with the idiomorphism of these crystals: hollow and skeletal forms, indeed, are frequently a result of a hurried crystallisation, as is so well seen in the artificial crystals of bismuth and of sodium chloride. On the other hand, while the hardness indicates a difference of the material from native graphite, the sharpness, separateness and completeness of the crystals, the brightness of the faces, the delicacy of the acicular projections, and especially of the obtuse, almost flat, square pyramids on some of the faces, are sufficient to prove that the form has never had any other than its present tenant, and that we have here an allotropic condition of crystallised carbon distinct from both diamond and graphite. And we may add that both of the recognised crystallised forms of carbon have long been standing difficulties for the crystallographer: as already pointed out, crystals of graphite are rarely more than mere tables of which there is a controversy as to the crystalline system, and those of the diamond are so different in their geome-

Digitized by Google

trical characters from the crystals of every other known substance that it cannot be satisfactorily determined whether they are to be referred to a holo-symmetric or to a hemi-symmetric type.

If it had been conceivable that the above characters, and the occurrence in the interior of meteoric iron, are compatible with a change in the material since the first development of the crystalline form, it would have been more easy to imagine that the change has been one of molecular re-arrangement than of substitution, and that the crystals were originally cubes of diamond. In fact, the diamond, when in cubes, has faces not very unlike those of the Youndegin crystals, and shows usually a similar bevelling of its edges by rounded faces of tetrakishexahedra. Or, again, it might be argued that during a hurried crystallisation of the carbon, the circumstances, though initially favourable to the formation of diamond, had finally only permitted of the existence of the carbon in a graphitic form.

The nature of the faces, the obtuse pyramid, the spherical growths, the acicular projections, and the parallel groups, are different, however, from anything ever met with in the diamond.

On examination of a large nodule of graphite from the Cocke (or Sevier) county iron, now in the British Museum collection, distinct graphitic crystals, cubo-octohedral in form, were found to be present.

As this kind of crystallised graphitic carbon is unknown among terrestrial minerals, and has so important a bearing on the formation of meteoric graphite, it may conveniently receive a distinctive name, and I therefore suggest the term *Cliftonite*—after Mr. R. B. Clifton, M.A., F.R.S., Professor of Physics at Oxford, who has long interested himself in the physical characters of minerals, and has given great encouragement to their study.

Digitized by Google

Supplementary Note on Felspar from Kilima-njaro. (Ante p. 11.)

By L. Fletcher, M.A., F.C.S., and H. A. Miers, M.A., F.G.S., of the Mineral Department, British Museum.

[Read January 11th, 1887.]

A CHEMICAL analysis of this felspar, to which our attention was directed by Professor Bonney,[1] and which was subsequently described[2] on crystallographic and optical grounds as orthoclase, shows it to be a soda-potash felspar of somewhat peculiar composition.

In the following table, the first two columns give the results obtained on analysis (Fletcher) of two loose crystals, of which the second was a twin-crystal of lighter colour than the first; the next two columns represent the same analyses if the oxide of iron (present as visible enclosures) and the loss on ignition are neglected; the numbers in the fifth column are obtained by taking the means of the numbers in the two preceding columns. For the sake of comparison the composition of felspars from Svenoer[3] and Tyveholmen[4] is given in the last two columns.

	Kilima-njaro.					Svenoer.	Tyveholmen.
	1st. Crystal.	2nd. Crystal.	1st. Crystal.	2nd. Crystal.	Mean.	Vogt.	Fischer.
Silica	60·52	61·03	62·59	61·74	62·17	61·35	61·90
Ferric Oxide ..	2·96	1·68					
Alumina ..	22·29	23·71	23·06	23·98	23·52	22·37	23·59
Lime	2·77	2·91	2·86	2·94	2·90	4·66	5·26
Magnesia ..	trace	trace				0·04	
Soda	6·48	6·83	6·70	6·91	6·80	6·59	2·60
Potash	4·63	4·38	4·79	4·43	4·61	4·97	6·64
Loss on ignition	0·18	0·24					
	99·83	100·78	100·00	100·00	100·00	99·98	99·99

The Oxygen ratio of the Kilima-njaro felspar is therefore

9·86 : 3·29 : 1

[1] Bonney. *Rep. Brit. Ass.* 1885, p. 682.

[2] Miers. *Min. Mag.* vii. p. 11.

[3] Brögger. *Die Silurischen Etagen* 2 *und* 3. 1882, p. 261.

[4] Mügge. *Neues Jahrbuch.* 1881 (2), p. 106.

Digitized by Google

If expressed as a mixture of Anorthite, Microcline, and Albite substance, this felspar would be represented as

$$An_1\ Or_{0\cdot94}\ Ab_{2\cdot11}$$

A re-determination of the optical and crystallographic characters (Miers) affords no proof that the crystals are not mono-symmetric. The angle between the cleavages is 90° (the deviation being never greater than 16′), and double images are given by *b* (=M) as frequently as by *p*.

The angle of extinction in clino-pinacoid sections is 4°20′ in the positive direction; in sections perpendicular to the clino-pinacoid the directions of extinction are parallel and perpendicular to that face

$$2\,E = 102°,\ 2\,H_a = 64°,\ 2\,H_o = 129°\ 30',$$

therefore $2\,V = 60°44'$; $\beta = 1{\cdot}5373$. (Sodium light.)

The acute bisectrix is negative. The obtuse bisectrix is positive.

Examination of a thin section cut perpendicular to both cleavages shows that the cross-hatching, referred to by Prof. Bonney and in the previous note, is formed by a vertical series of extremely fine lines intersected by a horizontal series of shadowy bands, both series being only visible near the position of general extinction between crossed nicols; each vertical line remains light on one side of this position, and becomes dark during a considerable rotation on the other side; it is impossible to assign any definite extinction angle; the average inclination to the vertical is about 10°. These lines have not the continuity of twin-lamellæ, they sometimes taper at the ends, and their general appearance suggests something more akin to microcline structure; there is no trace of them in sections parallel to the basal plane.

The spots alluded to in the previous note are seen in thinner sections to be glass enclosures, similar to those in oligoclase from Pantelleria (Rosenbusch, *Mikr. Phys.* 1886, Plate vii. fig. 3); there are also inclusions of the ground-mass, numerous crystallites, and a little apatite. This felspar therefore bears some resemblance to those of Teneriffe,[1] Mt. Esterel,[2] Pantelleria,[3] and especially to the felspars from the Svenoer Augite-Syenite and the Tyveholmen "Rhombenporphyr" (quoted above), a group with reference to which the names oligoclase, soda-orthoclase, soda-microcline, and anorthoclase[4] have been employed. Mügge[5] has lately described the felspar from the recent eruptive rocks of L. Naiwascha, Massai-land, a locality not far distant from Kilima-njaro, under the name of soda-microcline.

[1] Deville. *Comptes Rendus*, 19, 1844, p. 46.
[2] Rammelsberg. *Min. Chem.* 1875, ii. p. 569.
[3] Förstner. *Zeits. f. Kryst.* viii. 1884, p. 125.
[4] Rosenbusch. *Mikro. Phys.* 1885, p. 550.
[5] *Neues Jahrbuch.* Beil. Bd. 4, 1886, p. 291.

Digitized by Google

On the Occurrence of Greenockite at a New Locality.

By Prof. HEDDLE, F.R.S.E., &c.

[Read January 11th, 1887.]

MORE than a year ago I obtained a number of minerals in Boylestone quarry, which lies about a quarter of a mile north-west of Barrhead, near Glasgow.

Upon breaking up at home the very unwieldly druses which alone seem to occur at this locality, I found one which contained *Greenockite*.

A single bright yellow crystal only occurs, and it lies so deep in the specimen, between two mammillations of prehnite, that its form cannot be deciphered.

I was induced by the urgent solicitations of a local collector, to whom I mentioned the find, to refrain for a time from announcing it. His argument was that the mineral collectors of the neighbourhood should have the earliest chance of being supplied.

As I have myself fruitlessly visited the quarry since, and as even the occurrence of the ordinary zeolites is only very occasional therein, I conclude that time must elapse before more crystals are turned out.

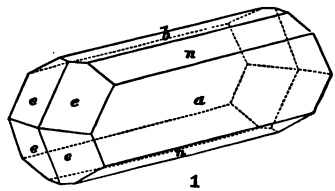
The rock-matrix, mode of occurrence, and mineral associates are here the same, or much the same, as occur at the other Scotch localities for this very rare substance.

The quarry is wrought for the most part for road metal; the rock is a friable dolerite, so soft as occasionally to have an almost wackenitic appearance. It is pervaded more by inosculating fissures than by well defined steam-holes; and these fissures are plugged for the most part by calcite.

Such a rock gives but little promise of zeolites. Olivine, however, occurs in abundance, and the finest crystal of that mineral which I have seen from Scotland was found here by Mr. John Young, the Curator of the Museum of the Glasgow University.

Its form is *n a b c*. (Fig. 1.)

It was about the same thickness, but only about one-third of the length of the figure.

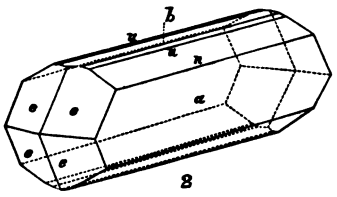


1

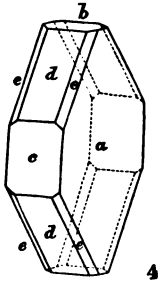
Figure 2 (p. 134) is a form in much smaller crystals observed by myself, chiefly in the denser portions of the rock.

In February 1882 I gave in this

Digitized by Google



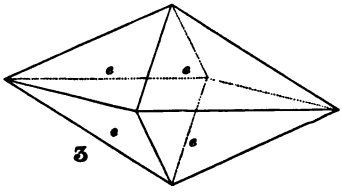
Magazine an analysis of the "ferrite" of Wallace Young, — expressing the opinion that it was a pseudomorph after either augite or olivine. The existence of *two* cleavages, apparently equally facile, alone prevented the conclusion that olivine was the mineral which had suffered change. In the immediate neighbourhood of Boyleston, and along the whole stretch of hill-face from Hatfield-Moss through Gleniffer to Fernese, the dolerite is studded with large crystals of twinned labradorite, and crystals of olivine in the form of figure 4.



This I find is the form of "ferrite," for not only are unaltered crystals of olivine in this form found, but also crystals in every stage of alteration with the brown and soft clay-like "ferrite." In ferrite the brachy-diagonal cleavage is perhaps still the most eminent, but the process of transformation of substance has exalted the macro-diagonal originally imperfect cleavage to a great extent.

Though both the above forms of olivine occur in close association, it is singular—at least, in the absence of an analysis of each we may say that it is singular—that it is only the mineral which occurs in the form of figure 4 which is changed into "ferrite."

This "ferrite" of Wallace Young is undoubtedly a substance differing altogether from that recognised by micro-petrologists under that name; and as Young's mineral had not only been analysed but fairly well described, and "held the field" long before the other, it is a pity that the ordinary scientific law has here been departed from in applying the same name to a new substance.



In order to illustrate the extreme diversity of form in which olivine, though rare in crystals of any size, is found in Scotland, I give the figure of crystals from the north-east end of the Kincraig at Elie in Fife. These crystals occur imbedded in a dense and tough blue-black basalt, and they are some inches in length. Their structure is granular, with so loose attachment of the granules that when exposed they are represented frequently only by hollow casts.

Digitized by Google

The only other locality at which I have seen crystals of olivine large enough to be figured, was the north side of the Bay of Talisker in Skye. The crystals are like figure 4, but without the faces *c* and *e*.

A granular crystal of huge dimensions was also found here by Mr. Peyton. Its form was like that of fig. 1 of Naumann, but its faces were rough, and it fell in pieces during the extraction.

A massive band of basaltic rock cuts the quarry in an east and west direction. This yields, though only very occasionally, large druses of analcime, also of prehnite with other zeolites; but, from the large size of the druses, the extreme toughness of the rock, and the feeble attachment of the zeolites thereto, it is with extreme difficulty that undefaced specimens can be obtained of a size suitable for cabinets.

I speak of what obtains at present, as, in the collection of Mr. D. C. Glen, there are several specimens fair in form and shape.

Where the amygdaloidal rock passes into basalt, which it does by insensible gradation, *native copper* is of frequent occurrence.

It is generally in very thin plates, which, being more or less extended in a single plane, seem to have filled rents; but the perfect continuity of the rock around the fringes of these plates, and their unusual brilliancy of colour, altogether preclude the conclusion that the copper was transfused into *pre-existent* fissures.

But seldom have these plates a thickness much greater than that of foil, though masses of about seven ounces have been found. The brilliancy of lustre disappears, and there is also a darkening of colour in the course of a few days. Minute crystals of copper also occur imbedded in clear crystals of calcite.

The zeolites which are found in this quarry occur for the most part in the dense basalt.

Prehnite is very much the most abundant. It usually forms large druses with mammillated groupings of crystals, which do not stand free or isolated at their terminations. The colours are for the most part of a dull green; but specimens of a bright green and also almost of a sulphur-yellow are occasionally found. The brighter green colours are evidently due to copper; minute distorted crystals and filaments of which, coated with powdery malachite (?), sometimes protrude from the surface of the prehnite. The cause of the colour of the yellow specimens is not evident.

That the prehnite is not the earliest formed of the zeolites is evident, for the sulphur-coloured prehnite, which is generally in isolated spheres, is disposed on the surface of analcime. The centres of the larger

Digitized by Google

masses of prehnite are colourless; and disposed throughout the green, or mixed with opaque white, there are blotchings of a pink or somewhat lavender tint. Slabs of this when polished are not unpleasing as brooch stones.

I have seen no free crystals of prehnite in this quarry.

The *analcime* is opaque milky white; it occurs in grouped crystals of the form *n*, from one-quarter to three-quarters of an inch in size. The specimens are as fine of the white variety as any in Scotland. Distorted crystals occur; the distortion being a shortening along the octahedral axis.

Small opaque isolated crystals of a beautiful flesh colour also occur.

Thomsonite occurs of two varieties. Grouped bunches of radiating acicular crystals embedded in analcime; and fan-shaped groups of diverging flat crystals which stand free from the surface of clustered crystals of analcime. The former of these varieties is in crystals two inches in length—these have no terminations; the latter are about one inch by an eighth of an inch in thickness. These have the unusual development of faces figured. (Fig. 5.)

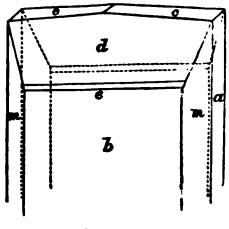


Fig. 5.

Lying upon the surface of the prehnite there rarely occur groupings of interlacing but isolated crystals of *natrolite*, disposed upon the sides of the crystals, loosely attached and sometimes doubly terminated. The crystals are nearly two inches in length, but only about a thirty-second in thickness. Although they have only the ordinary form *m o*, they are probably the finest found in Scotland.

Poor specimens of *Laumontite* occur.

In 1855 I announced the occurrence of the scaly variety of Göthite termed *rubin-glimmer* along with zeolites at Kilpatrick; the same substance occurs here in groups of rosette-like crystals. It was by some taken for crystallised native copper! This crystal-bloom attaches itself only to the analcime and to the Thomsonite, but it sometimes lies as a scaly down on the surface of crystals of *calcite*.

These last occur, though rarely, in several fine and highly complex forms which I am at present figuring. They sometimes are two inches in length.

Notwithstanding the apparent richness of this locality, it is one which cannot yield many specimens for the cabinet, unless the lapidaries' wheel be used for the fashioning of them;—even a well-skilled hammerer producing only uncouth and shapeless specimens.

The chief interest connected with this quarry is in the zeolites being

Digitized by Google

solely of the lime and soda class, and this is clearly explained by the abundance of *labradorite* in the unchanged rocks of the neighbourhood. *Saponite*, however, occurs as a decomposition product, filling the smaller drusy hollows.

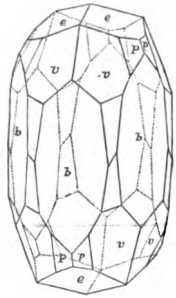
Digitized by Google

On a Form of Calcite from Heilim, Sutherland.

By Prof. Heddle, F.R.S.E., &c.

[Read January 11th, 1887.]

THE form of Calcite depicted in the figure occurs in the quarries which were for some time worked in the dolomite of the semi-peninsular islet at Heilim, on Loch Erribol, Sutherland.



Cavities in the rock are rare, and well developed forms of calcite still more so.

The only other forms which I noticed were the common "nail-head" and the "dog-tooth,"—the latter being somewhat modified.

The dolomitic constitution of the rock is against the formation of distinct crystals, which I do not remember to have seen elsewhere in its long stretch southward to Applecross.

The crystal drawn is interesting from the nearly equal balancing of its component forms in a combination which I have not seen before figured.

Digitized by Google

Note on the Occurrence of Bismutite in the Transvaal.

By Henry Louis, A.R.S.M., F.I.C., &c.

[Read January 11th, 1887.]

THIS mineral occurs plentifully, though finely disseminated, in the veins of auriferous quartz in the Lydenburg district of the Transvaal. These veins are often capped by a "gossan" of brown hæmatite, crystalline, amorphous, or at times pseudomorphous after iron pyrites; a good deal of similar brown hæmatite occurs also throughout the veins themselves. The Bismutite is disseminated irregularly through the veins, and also occurs in small pockets in the ferruginous gossan; it is from the latter source that the mineral was obtained for the subjoined description and analysis.

It is amorphous, pulverulent; colour greenish yellow to lemon-yellow, more rarely brownish yellow; opaque (feebly translucent, with waxy lustre under the microscope); its hardness appears to be about 3, but cannot well be determined on account of its pulverulent character. Specific gravity 6·86. The following is an analysis of it (great accuracy could not be attained as the quantity to be operated on was very small):—

Insoluble matter (quartz)	0·9
Bi_2O_3...	79·6
CO_2	7·2
H_2O	2·7
Oxide of iron, traces of lime, etc.	9·6[1]
	100·0

This analysis gives as the percentage composition of the Bismutite itself, the following:—

Bi_2O_3	88·95
CO_2	8·04
H_2O	3·01
	100·00

[1] No other heavy metals except Bismuth were present.

Digitized by Google

This composition gives for the mineral the formula $Bi_2H_2CO_6$, or $Bi_2H_6O_6+(Bi_2O_3)_2$, $3CO_2$. This formula differs somewhat from that hitherto assigned to Bismutite, but corresponds well with the composition of the mineral here described, the percentage composition demanded by the above formula being

Bi_2O_3	88·22
CO_2	8·36
H_2O	3·42
	100·00

It is worthy of notice that this is not the only instance of the paragenesis of Bismutite with auriferous quartz, as a similar occurrence has been recorded from South Carolina.

Digitized by Google

Apatite from a New Locality in Eastern Cornwall.

By R. H. Solly, F.G.S., Demonstrator in Mineralogy to the University of Cambridge.

[Read January 11th, 1887.]

IN the last Number of the Society's Journal I described some crystals of apatite (francolite variety) from St. Just district of Western Cornwall; I have now to bring to the notice of the members some very fine beautiful crystals of this same mineral which I have received from Mr. Henson.

In point of beauty and lustre they far surpass any of the apatites that have yet been found in England.

The crystals are in the form of hexagonal prisms, doubly terminated with basal planes and narrow pyramid planes; colour pale bluish green, translucent with strong vitreous lustre.

They vary in size from a pin's head to half-an-inch across.

The following forms are nearly always present:—*o* (111) well developed, *i* (231), *x* (120), *z* ($13\bar{1}$) narrow *r* (100), small r_1 ($\bar{1}22$), smaller *a* ($10\bar{1}$) well developed, *b* ($2\bar{1}\bar{1}$) smaller; the two latter planes deeply striated parallel to their intersection with one another.

The crystals are deposited in voynes in the granite associated with white felspar, dark brown tourmaline, gilbertite, smoky quartz, silvery mica and pseudomorphs of gilbertite after quartz. These so-called pseudomorphs by incrustation are nothing more than the remains of the coating of gilbertite on crystals of quartz, which have been afterwards either dissolved or broken away.

These crystals of apatite in their development resemble those fine dark blue crystals found at St. Michael's Mount more than fifty years ago, but in colour are closer to the Ehrenfriedersdorf, and in lustre to those brilliant crystals from Knappenwand, Untersulzbachthal, Salzburg.

The association of brown tourmaline with gilbertite I have not seen before in Cornwall. In other respects the matrix is very similar to that from Stenna Gwyn, near St. Austell.

Digitized by Google

Celestine from a New Locality in Gloucestershire.

By R. H. Solly, F.G.S., Demonstrator in Mineralogy to the University of Cambridge.

[Read January 11th, 1887.]

THE great similarity which exists in the crystallographic and optical constants, cleavage, and absence of twinning in the isomorphous rhombic sulphates is especially marked in Barytes and Celestine, but though the combination of forms is sometimes the same, yet up to the present time a marked individuality has been perceived in Celestine crystals which has made it easy to recognise the one mineral from the other.

The crystals of Celestine from near Bristol in the red marl, those associated with sulphur from Sicily, or the large flat more or less bluish tabular crystals from Strontian Island, Lake Erie, are varieties which are seldom if ever mistaken for Barytes.

But some fine large semi-transparent white crystals that have come into the hands of Mr. Henson, and which were quite lately found in Gloucestershire, resemble so closely in form crystals of Barytes from Dufton, Westmoreland, that it was only by measurement I was able to be sure of their identity. The following forms are present:—*c* (001) large, *o* (101), *d* (012) well developed narrow, *g* (013), and small *m* (110).

Another habit is also found on crystals from the same place; *c* and *m* largely developed with small *o* and *d*, closely resembling except in colour those crystals of Barytes from Frizzington, Whitehaven, Cumberland.

I believe I may further state that these last crystals are the largest by far that have yet been found of Celestine in this country, and in size remind one of the Lake Erie crystals.

Digitized by Google

Note on the presence of Lead in Calcites from the Leadhills District.

By J. Stuart Thomson, Esq.

[Read January 11th, 1887.]

THE not unfrequent occurrence of the variety of Calcite, containing Carbonate of Lead and known as "Plumbo-calcite," at the Leadhills district, suggested that an examination of some of the ordinary Calcites from this locality, for Lead, might be of interest. The specimens for this examination were most kindly put at my disposal by Dr. Wilson. All of them were ordinary Calcites, none consisting of the recognised Plumbo-calcite.

The following is a brief description of the specimens and the result of their analysis :—

No. 1. Locality: Bay-mine, Wanlockhead. Dog-tooth-spar, opaque, milky, appeared to be water worn.

No. 2. Locality: Bay-mine, Wanlockhead. Fine transparent scalenohedrons.

No. 3. Locality: Bay-mine, Wanlockhead. Similar to No. 2, but from a different part of the workings.

No. 4. Locality: Bay-mine, Wanlockhead. Fibrous, radiating, white.

No. 5. Locality: Beltongrain-mine, Wanlockhead. This consisted of two distinct growths of crystals, the larger and older generation (No. 5*a*) being crystallised after +R, while the smaller and more recent crystals (5*b*) were $-\frac{1}{2}$R, +R, $-n$R (probably $-5\bar{R}$ or -8R).

No. 6. Locality: Bay-mine, Wanlockhead, Fibrous, massive, white, translucent.

No. 7. Locality: Bay-mine, Wanlockhead. Rhombohedrons, white, edges stained dark brown.

No. 8. Locality: Leadhills. Large distinct crystals $-\frac{1}{2}$R and ∞P2, white, translucent.

The following table shows the specific gravity and the amount of Carbonate of Lead found in the above specimens :—

	Sp. Gr.	$PbCO_3$.
No. 1	2·696	0·22 per cent.
,, 2	2·544	trace
,, 3	2·618	trace

Digitized by Google

	Sp. Gr.	$PbCO_3$.
No. 4	2·708—2·710	0·91
,, 5*a*	2·758—2·766	3·51
,, 5*b*	2·699	0·86
,, 6	2·688—2·724	0·79
,, 7	2·683	0·20
,, 8	not taken	none

Naumann gives the specific gravity of Plumbo-calcite as 2·772 to 2·824, while the $PbCO_3$ ranges from 2·34 per cent. (Delesse) to 7·74 per cent. (v. Hauer), and 7·8 per cent. (Johnston). The only one of the foregoing analyses which approximates to these figures is that of No. 5*a*. The results generally show that Lead is not unfrequently present in the Calcites of this district, and an examination of the Calcites from similar lead mining districts for lead would be of interest.

It may be noted that a specimen of Aragonite from Wanlockhead gave no indication of lead.

Digitized by Google

On the Use of the Gnomonic Projection; with a Projection of the Forms of Red Silver Ore.

By H. A. Miers, M.A.

[Read January 11th, 1887.]

IF the planes of a crystal be replaced by lines drawn perpendicular to them through a point the intersection of the sheaf of lines so formed with the plane of the paper is the Gnomonic Projection of the crystal; each face being represented by a point and each zone by a line joining two such points. This projection, which has been frequently used and fully described, has generally been employed to represent the symmetrical disposition of the faces, the plane of the figure being a plane of symmetry.

But the practical value of the projection is best seen when it is used either as a graphic representation of the forms of a mineral, or as a method of drawing a perspective figure of any part of a crystal.

I.—To represent all the forms of a mineral (which does not belong to either of the two oblique systems) the plane of the figure must cut the whole group of normals enclosed within three adjacent planes of symmetry.

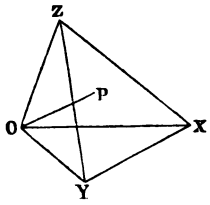


Fig. 1.

Let OX, OY, OZ (fig. 1), be any three normals, the angles between which are

$$YOZ=\xi$$
$$ZOX=\eta$$
$$XOY=\zeta$$

Let XYZ be the plane of the figure of which the normal OP is inclined to the first three normals at the angles

$$POX=\alpha$$
$$POY=\beta$$
$$POZ=\gamma$$

Digitized by Google

Let OP=p. Then

$$YZ=K.\ p\cos\alpha\ \sqrt{\cos^2\beta+\cos^2\gamma-2\cos\beta.\ \cos\gamma.\ \cos\xi}.$$

$$ZH=K.\ p\cos\beta\ \sqrt{\cos^2\gamma+\cos^2\alpha-2\cos\gamma.\ \cos\alpha.\ \cos\eta}.$$

$$XY=K.\ p\cos\gamma\ \sqrt{\cos^2\alpha+\cos^2\beta-2\cos\alpha.\ \cos\beta.\ \cos\zeta}.$$

where $K=\dfrac{1}{\cos\alpha.\ \cos\beta.\ \cos\gamma}$.

And

$$PX=p\tan\alpha$$
$$PY=p\tan\beta$$
$$PZ=p\tan\gamma$$

Thus the triangle XYZ may be drawn, and the position of P may be laid down for any position of the plane of the figure at any required distance (p) from the origin.

Then any other point of the system being laid down from its known angles, the whole system of points corresponding to possible planes of the crystal may be mapped out by the intersections of lines joining these points.

The dihedral angles are measured on the projection by means of the "Circle of Projection" described from centre P with radius equal to p.

The following constructions are given in all descriptions of the gnomonic projection :—

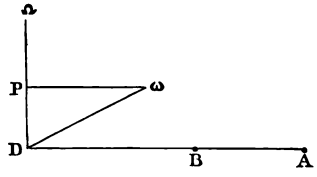


FIG. 2.

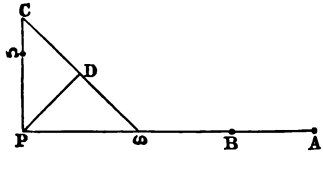


FIG. 3.

(1.) To find the angle between two normals whose projections are AB (fig. 2). Through P draw PD perpendicular to AB, meeting AB in D; draw Pω parallel to AB, meeting the circle of projection in ω. Along PD take DΩ=Dω. Then the angle between any pair of normals whose projections AB lie in the zone line ABD is the angle subtended by AB at Ω.

(2.) To find the angle between two zones whose projections are CA, CB (fig. 3). Join CP; draw Pω perpendicular to CP, meeting the circle of projection in ω. Join Cω; draw PD perpendicular to Cω, and in PC take PΩ=PD.

Then the angle between any pair of zones whose projections CA, CB intersect in the point C is the angle subtended at Ω by their intersections with Pω.

Digitized by Google

With the help of these constructions any crystal may be easily projected.

In the systems with rectangular axes and in the Hexagonal and Rhombohedral system the construction of the figure is much simplified by a convenient choice of the plane of projection.

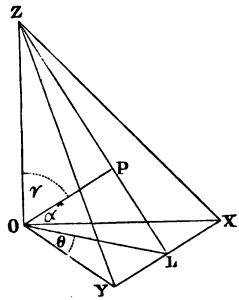


FIG. 4.

If OX, OY, OZ (fig. 4) are the rectangular axes in the former, or two lateral axes and the vertical axis in the latter,

$$\cos\alpha=\cos\beta=\sin\gamma\cos\frac{\zeta}{2}=\sin\gamma\cos\theta \text{ where } 2\theta=\zeta.$$

Let ZP meet XY in L; then ZLX=90°.

$$\text{ZL}=\frac{p}{\sin\gamma\cos\gamma} \quad \text{and} \quad \text{XL}=\frac{p\tan\theta}{\sin\gamma}$$

$$\therefore \frac{\text{LX}}{\text{LZ}}=\tan\theta.\cos\gamma \quad \ldots \quad \ldots \quad \ldots \quad (a)$$

$$\text{PL}=\text{ZL}\cos^2\gamma \quad \ldots \quad \ldots \quad \ldots \quad (b)$$

$$p=\frac{\text{PZ}}{\tan\gamma}=\frac{\text{PX}}{\tan\alpha} \quad \ldots \quad \ldots \quad \ldots \quad (c)$$

The triangle XYZ may be drawn from (*a*).
The point P may be projected from (*b*).
The circle of projection may be described from (*c*).
In the Cubic, Tetragonal, and Orthorhombic systems $\theta=45°$.

Then if $\gamma=45°$, $\cos\alpha=\frac{1}{2}$.

$$\frac{\text{LX}}{\text{LZ}}=\frac{1}{\sqrt{2}}, \quad \text{PL}=\frac{1}{2}\text{ZL}, \quad p=\text{PZ}.$$

In the Rhombohedral and Hexagonal system $\theta=30°$.

Digitized by Google

Then if $\cos\gamma=\frac{1}{\sqrt{3}}$, $\cos\alpha=\frac{1}{\sqrt{2}}$, $\alpha=45°$.

$$\frac{LX}{LZ}=\frac{1}{3},\quad PL=\frac{1}{3}ZL,\quad p=PX.$$

As an example of this mode of projection, Plate IV. gives a figure of all the forms of Pyrargyrite and Proustite which have been recorded, together with a number recently observed by myself. This figure is the intersection of the face-normals by a plane inclined at 54° 44½′ to the vertical axis, and at 45° to two adjacent lateral axes, and at a distance of $b*=84{\cdot}85$ mm. from the origin, where * is the projection of its own normal on the plane of the figure.

The forms marked with an asterisk are new; h' and λ', which do not appear as separate points on the projection, refer without doubt to the same form. *Vid.* explanation of Plate. (p. 149.)

II.—To draw a perspective figure of any part of a crystal from the projection, it is only necessary to represent the edge between any two faces by a perpendicular to the line joining their projections.

Although it is impossible to project more than a limited number of the faces, the complete crystal may be drawn without difficulty when once the intersections of the planes of symmetry with the plane of the figure have been drawn, by the repetition of the zone-lines in the figure across one or other of these intersections.

The gnomonic projection has the advantages that (like the linear projection) it is a figure actually formed by the crystal and not a representation; the constructions are all made by straight lines; each face is represented by a point; the anharmonic ratio of four faces is the ratio of their intercepts measured along a straight line; and it is by far the easiest graphic method of determining the position of any face. In forming the perspective figures from it no construction lines are required.

Digitized by Google

a	101		*a'*	72$\bar{1}$		*A*	15 3 $\bar{4}$		*A'*	31$\bar{1}$		*α*	42$\bar{3}$		*α'*	10 1 1		Γ	33$\bar{1}$	*	Γ'	730
b	2$\bar{1}$1		*b'*	411	*	*B*	17 5 $\bar{4}$		*B'*	737		*β*	5$\bar{1}$4		*β'*	11 $\bar{4}$ $\bar{4}$		Δ	19 0 $\overline{13}$	*	Δ'	17 0 $\overline{13}$
c	40$\bar{3}$		*c'*	15 2 $\bar{1}$	*	*C*	12 1 $\bar{3}$		*C'*	6$\bar{1}$3		*γ*	50$\bar{3}$		*γ'*	17 $\bar{7}$ $\bar{7}$		Θ	17 $\bar{8}$ $\bar{9}$	*	Π'	13 6 0
d	21$\bar{1}$		*d'*	55$\bar{9}$	*	*D*	54$\bar{8}$		*D'*	13 6 $\overline{11}$		*δ*	32$\bar{1}$		*δ'*	11 $\bar{5}$ $\bar{5}$		Λ	540	*	Ω'	74$\bar{8}$
e	110		*e'*	10 3 0		*E*	21$\bar{2}$		*E'*	33$\bar{2}$		*ε*	20 11 $\bar{7}$		*ε'*	772	*	Ξ	17 6 $\bar{7}$			
f	22$\bar{3}$	*	*f'*	72$\bar{5}$		*F*	9 5 $\overline{10}$	*	*F'*	40 7 $\overline{11}$		*ζ*	90$\bar{5}$		*ζ'*	771	*	Π				
g	71$\bar{2}$		*g'*	12 1 $\bar{4}$		*G*	43$\bar{6}$	*	*G'*	810		*η*	28 13 $\overline{17}$		*η'*	84$\bar{3}$		Σ	8$\bar{1}$1			
h	55$\bar{4}$		*h'*	51$\bar{3}$		*H*	8 5 $\overline{10}$		*Γ'*	17 0 $\overline{11}$	*	*θ*	97$\bar{8}$	*	*θ'*	720		Υ	13 7 0			
i	51$\bar{1}$		*i'*	52$\bar{6}$		*I*	611		*K'*	13 7 $\overline{14}$		*κ*	70$\bar{5}$				*	Φ	520			
k	11 1 $\bar{4}$		*k'*	62$\bar{7}$	*	*K*	21 6 $\bar{5}$	*	*N'*	17 0 $\overline{15}$		*λ*	11 4 0		*λ'*	41 8 $\overline{25}$	*	Ψ	13 2 $\bar{3}$			
l	62$\bar{3}$		*l'*	13 $\bar{1}$ $\bar{4}$	*	*L*	19 4 $\bar{5}$		*P'*	61$\bar{2}$		*μ*	13 4 $\bar{2}$		*μ'*	85$\bar{3}$		Ω	62$\bar{1}$			
m	3$\bar{1}$1	*	*m'*	82$\bar{3}$		*M*	63$\bar{2}$		*W'*	332		*ν*	16 4 $\bar{5}$		*ν'*	67 22 7			10 0 $\bar{7}$			
n	40$\bar{1}$	*	*n'*	7$\bar{1}$4		*N*	53$\bar{6}$		*X'*	221		*ξ*	610		*ξ'*	25 1 $\overline{11}$						
o	111		*o'*	12 2 $\bar{5}$		*P*	32$\bar{3}$		*Y'*	22$\bar{1}$	*	*π*	19 11 $\overline{12}$		*π'*	90$\bar{7}$						
p	210	*	*p'*	12 $\bar{5}$ $\bar{6}$	*	*Q*	15 1 $\bar{3}$	*	*Z'*	13 9 $\bar{1}$1	*	*ρ*	64$\bar{3}$		*ρ'*	8$\bar{1}$4						
q	32$\bar{4}$		*q'*	73$\bar{5}$		*R*	811					*σ*	41$\bar{1}$		*σ'*	9$\bar{1}$6						
r	100		*r'*	16 1 1	*	*S*	43$\bar{1}$					*τ*	3$\bar{1}$2		*τ'*	830						
s	11$\bar{1}$	*	*s'*	70$\bar{3}$		*T*	4$\bar{1}$1					*υ*	320		*υ'*	9 4 $\overline{11}$						
t	310	*	*t'*	18 4 $\bar{7}$		*U*	91$\bar{2}$					*φ*	510		*φ'*	73$\bar{9}$						
u	211		*u'*	17 16 $\overline{25}$	*	*V*	13 1 $\bar{4}$					*χ*	82$\bar{1}$		*χ'*	73$\bar{3}$						
v	20$\bar{1}$		*v'*	51$\bar{3}$		*W*	92$\bar{3}$					*ψ*	30$\bar{1}$		*ψ'*	41$\bar{2}$						
w	410		*w'*	50$\bar{1}$		*X*	83$\bar{4}$					*ω*	530		*ω'*	95$\bar{9}$						
x	31$\bar{3}$	*	*x'*	26 5 $\bar{7}$		*Y*	81$\bar{3}$															
y	30$\bar{2}$		*y'*	15 $\bar{2}$ $\bar{8}$	*	*Z*	50$\bar{4}$															
z	51$\bar{2}$		*z'*	430																		

Digitized by Google

Note on some Specimens of Glaucophane-rock from the Ile de Groix.

By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

[Read May 10th, 1887.]

In my description of a Glaucophane-eclogite[1] from the Val d' Aoste, I alluded to the occurrence of a rather similar rock in the Ile de Groix (off the south coast of Brittany) in the following words:—"In the Ile de Groix the glaucophane occurs in no great abundance, with greenish mica, epidote, garnet, hornblende, and but little quartz." My knowledge of the rock, as then stated, was from one or two specimens only; but in the autumn of 1886 I paid a short visit to the Ile de Groix in order to see the rock in the field. I then found that in the above phrase I had unwittingly done an injustice to this locality for glaucophane, for I obtained specimens in which that mineral is even more abundant and almost as well developed as in the rock from the Val d' Aoste. On this account, and as the locality is rarely visited,[2] I venture to think that a few notes may be interesting to the Society, although the rock has been already excellently discussed by Dr. Charles Barrois,[3] to whom I am much indebted for information about this and other interesting localities in Brittany.

The Ile de Groix chiefly consists of mica-schists. These are fairly coarsely crystalline, contain much silvery mica in pretty large flakes, with quartz, and not seldom garnet. Chloritoid is frequently present, the flakes being sometimes nearly ·5″ in diameter. Hence Dr. Barrois names the group *schistes à chloritoide*. Occasionally the schist is anthracitic, and at the eastern end of the Island there is a felspathic gneiss. The whole group has evidently been much modified by intense pressure subsequent to the general crystallisation, which has produced what I have termed 'cleavage-foliation' as contrasted with 'stratification foliation.'[4] In mineral composition and general aspect it has a considerable resemblance

[1] *Min. Mag.* Vol. VII., p. 1.

[2] It can be reached by a steamer from Lorient. As this starts about 6 a.m. it would be possible to visit some of the localities and get back the same evening to Lorient, but it is better to pass the night in the Island. Near the landing place is an auberge; the entertainment is homely but the people are kindly.

[3] *Annales de la Soc. Géol. du Nord.* Vol. XI. p. 18.

[4] *Presidential Address to the Geol. Soc.* 1886. See *Proceedings*, Vol. XLII.

Digitized by Google

to the schists which occur towards the middle, as it seems, of the Alpine series.[1]

The glaucophane-rock, termed by Dr. Barrois, whose name I will adopt for convenience in this paper, glaucophane-amphibolite,[2] occurs in the neighbourhood of Locmaria, about the middle of the south side of the Island, and at the eastern end around Fort de la Croix, intercalated in the *schistes à chloritoide* in masses, generally several yards, occasionally (according to Dr. Barrois) as much as fifty metres thick. I paid particular attention to the relations of the amphibolite to the *schiste à chloritoide*, a point on which Dr. Barrois hesitates to decide. As my own examination was comparatively cursory, I do not like to speak at all positively, but the evidence appeared to me as in favour of the amphibolite being intrusive in the schist. The one rock did not seem to graduate into the other; the line of parting was not only sharp but also occasionally suggested an intrusive junction. In one place, it is true, I observed that the mica-schist was interbanded with the outer part of the amphibolite, but this might be explained by a crushing out of some fragment of the mica-schist caught up in an intrusive mass of amphibolite.[3] The latter rock always exhibits some schistosity, and at the east end of the Island is occasionally distinctly foliated. This structure is parallel with the cleavage foliation in the *schistes à chloritoide*. About Locmaria its dip is slightly to the east of south, but nearer the eastern end of the Island it becomes about south-west, which appears to be the dominant direction; the angle varies from about 15° to 20° or a little more. The amphibolites, as mapped by Dr. Barrois, appear to cut obliquely across this structure, as we should expect intrusive dykes or sheets to do; moreover the amphibolite of the Ile de Groix (except for the glaucophane and the garnets) resembles in its general structures, mode of weathering, &c. the amphibolites which I saw on the Breton Coast about the embouchure of the Pouldu, and at Roscoff, which I have no doubt are intrusive rocks, modified by subsequent pressures and consequent mineral change.

The glaucophane-amphibolite in the bay south of Locmaria is less schistose than that in the east of the Island, and it bears a remarkable resemblance to the rock from the Val d' Aoste. True, it is in places fairly

[1] *e.g.* Apparently above the rather friable banded gneisses, as on the south side of the St. Gothard group.

[2] Otherwise I should have retained the name *eclogite*, used in my last paper; for in all the specimens noticed in this garnet is present abundantly.

[3] Rather large but ill-preserved crystals of andalusite are developed near the junction of the rocks, chiefly in the mica-schist; possibly this may be indicative of an intrusion.

Digitized by Google

well banded with epidote and hornblende (as is excellently seen in the pebbles so abundant on the beach), and these bands are occasionally puckered, but in some specimens the foliation is only slight. In the latter case the rock is extremely tough, and, as in the Val d' Aoste, it is difficult to break off good specimens. Macroscopically the resemblance of the two rocks is very close, even to the presence of occasional small flakes of a silvery mica. Microscopically also there is but little difference. There are reddish garnets, epidote, hornblende, glaucophane, as the chief constituents; with quartz, mica, iron-oxide,[1] sphene (?), and rutile as accidentals. The only difference which I observe is that in my slide of this variety of the Ile de Groix rock the garnets have a more definite crystalline outline, there is less green hornblende and more glaucophane; but the crystals of the latter mineral are not quite so large individually and less perfectly defined externally than in the Val d' Aoste rock. But I attach no importance to these differences, because they might not be maintained if a slice were taken from another specimen—the rocks are substantially identical, so far as I can see.

The glaucophane-amphibolites in the eastern part of the Island are generally rather coarser in texture and more definitely foliated than the last named. I brought away four varieties, one of which exhibits a very distinct foliation, the glaucophane and epidote occurring in thin but well-defined bands. The garnets, which are less numerous, are rather larger than usual, being sometimes nearly a quarter of an inch in diameter. Of the other specimens, one differs microscopically from that described above in having a slightly more definite orientation of the minerals. It is very rich in glaucophane. The second, as might be expected from its general appearance, only presents slight differences from the last named, the grains of glaucophane having a less definite orientation. Transverse sections of this mineral are commonly rather less than ·02″ in diameter, longitudinal about ·03″, sometimes less, sometimes a little more. The third specimen, however, which is extremely rich in glaucophane, has the crystals of that mineral larger, for sometimes they are almost double of the above dimensions; the garnets also often are about a quarter of an inch in diameter.

Rutile, as identified by Dr. Barrois, is rather abundant in these amphibolites, and is the sole mineral included in the glaucophane. I think that the mineral in the Val d' Aoste rock, which I suggested might be an impure sphene, is very probably a dark coloured, and so perhaps an

[1] Both magnetite and hematite occur variably.

Digitized by Google

impure rutile. In the Ile de Groix rock the rutile is lighter coloured and more translucent than in that from the Val d' Aoste, but brown grains occasionally occur; also it is more generally disseminated, so as to be almost a normal constituent. The garnet in the former is often rather full of inclusions of a filmy mineral of slightly irregular outline, bright coloured between crossed nicols and with an oblique extinction. These sometimes occur in wavy or bent lines, which may possibly indicate a structure in the rock anterior to the formation of the garnet.[1] As in the Val d' Aoste rock, I think the garnet was formed before the glaucophane. Here also the latter mineral sometimes passes at the exterior into a rather fibrous dark green mineral, whether by subsequent change or the reverse it is difficult to determine, but I incline to his former view. For a very full discussion of the minerals in the Ile de Groix rock I may refer to Dr. Barrois' elaborate memoir.

I have lately received from Prof. B. Kotō, of Japan, a copy of a Paper[2] describing the discovery of glaucophane in that island. It occurs in a schist, containing, together with "epidote, yellowish green crystals of garnet, quartz, some felspar, rutile, also specular iron" and other constituents, among them "piemontite or manganese epidote." The rock is found in the crystalline-schist system, which is extensively developed, especially in the central mountain chains of the island of Shikoku." He gives an analysis of the glaucophane, and, as his Paper may not be very easily consulted in England, I venture to quote it. The mineral gave, separated by the Thoulet solution :—

SiO_2	=	56·71
Al_2O_3	=	15·14
Fe_2O_3	=	9·78
FeO	=	4·81
CaO	=	4·80
MgO	=	4·88
Na_2O	=	4·88
K_2O	=	0·25
		100·15

S.G. 2·9912.

Prof. Kotō also notices the occasional passage of the glaucophane grains at their exterior into a fibrous mineral, which he names crocidolite,

[1] They might be of secondary origin, formed by solution of the garnet along lines of strain; but if this were so, it would be difficult to explain their being bent into S-like folds, as they are in at least two of the garnets.

[2] *Journal of the College of Science, Imperial Univ.* Vol. I. Part I. (1886).

Digitized by Google

regarding it as of later origin; in corroboration of this view, he states that "for microscopic examination a number of specimens had been prepared from different localities, and glaucophane in these slides in the course of some weeks totally lost its original blue colour and turned into a light green substance."[1] He also describes the occurrence of glaucophane in a serpentinous rock. Here the mineral is formed from diallage, as described by myself in the case at Pegli, near Genoa. He regards it as one generally of secondary formation. The occurrence of glaucophane in schists in California has been recently noticed by Dr. Becker (*Amer. Jour. Sci.* Ser. iii. Vol. xxxi. p. 348); but some of the theoretical conclusions in his paper will in my opinion be difficult to substantiate.

[1] I have not noticed any change in my slides; those from the Val d'Aoste are quite eighteen months old.

Digitized by Google

Notes on the Microscopical Structure of some Eruptive Rocks from Armenia and the Caucasus.

By Hjalmar Gylling, Helsingfors.

[Read May 10th, 1887.]

In 1881-1882 Dr. A. Brotherus and his brother, A. H. Brotherus, made a botanical tour in Armenia and the Caucasus; the younger gentleman collected a few specimens of rocks met with during their journey, which, on his return, he kindly left to be examined by me.

This material consisted of later eruptive rocks; it was scanty, but as it was obtained in places from which we have no earlier information of a similar character, I have not thought it uncalled for to make in the following lines a slight contribution to our knowledge of the geognosy of the regions in question.

The microscopical analysis of rocks from the Caucasus made by Tschermak, Lagorio, and Möhl[1] relate in part to the identical rocks that I shall describe, but the localities are different.

The augite-andesites collected by Favre and described by Tschermak[2] are specimens from Kasbek and its vicinity; those again collected by Abich and described by Lagorio[3] are from Kasbek, Ararat, and Kobi. The material at my disposal, consisting of *liparite*, *augite-andesite* and *obsidian*, was mostly found along the general caravan road between Alexandropol in the Caucasus and Charput in Turkish Armenia.

To begin with *liparite*.

Liparite from Kars.—To the naked eye this rock exhibits the following appearance. In a reddish brown cryptocrystalline ground-mass we find porphyritically embedded minute sanidine crystals measuring 1·5-2 mm. in length and 0·5 mm. in breadth. On older fractures the otherwise clear sanidine has by decomposition assumed a yellowish tint. Under the microscope the ground-mass is found to consist throughout of a light-brown microfelsitic substance, in which sanidine, quartz, and a few glass particles are embedded. The sanidine crystals are of vitreous lustre, often

[1] Möhl, *Kaukasische Gesteine, Naturwiss. Ges. Isis.* Dresden, 1878.

[2] *Tschermak, Felsarten aus dem Kaukasus, Min. Mitth.* 1872, 2 Heft. p. 107; and *Min. Mitth.* 1875, p Heft. p. 131.

[3] *Lagorio A. Die Andesite des Kaukasus, Dorpat* 1880.

Digitized by Google

coloured yellow-brown by decomposition-products of iron which occur in the numerous fine cracks by which they are traversed. They constitute exclusively simple crystals, extinguishing parallel with the traces PM and lM. Frequently the sanidine crystals are broken and cut off, and the ground-mass is pressed in between the fragments. The sanidine does not contain any interpositions. (Fig. 1.)

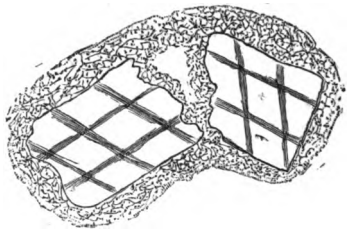


Fig. 1.

The quartz grains embedded in the ground-mass are distinguished by their unusual translucency and by the particularly sharp-defined outlines of their edges. They do not contain interpositions any more than the sanidine.

The glass particles lying scattered in the ground-mass have a dirty-grayish, and are sometimes tarnished of a brown or greenish colour by the action of iron oxide.

As accessory component parts there are apatite and magnetite, the last-mentioned decomposing into red oxide of iron.

Liparite from Charput.—Macroscopically this variety of liparite differs considerably from the preceding one. To the naked eye there appear in the grayish-green microcrystalline or dense ground-mass, porphyritically embedded sanidine crystals, as well as crystals of quartz. These last-mentioned are here, as in the preceding rock, clear and well developed, with exceedingly sharp outlines against the ground-mass.

Under the microscope the ground-mass of the liparite exhibits a well marked microfluxion structure. The sanidine crystals and the quartz individuals are lying in the ground-mass as if immersed in it. Under high microscopic powers the ground-mass presents the aspect of a covering or coat of both lenticular and somewhat lengthened glass particles pressed exceedingly close to one another, between and on which are attached numberless minute globulite-like grains of a greenish colour. Not unfrequently the glass base is developed into spherulitic structures. (Fig. 2.)

The quartz individuals lying in the ground-mass contain included small portions of the glass base of the same, but are otherwise destitute

Digitized by Google

of any interpositions. This last-mentioned is also the case with the sani-

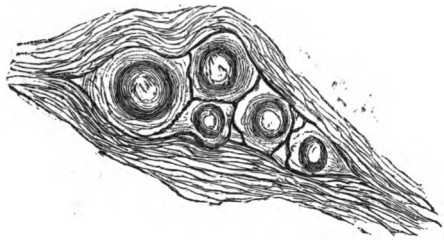


Fig. 2.

dine, which is traversed by numerous cracks and is, to all appearance, doomed to destruction by way of incipient decomposition.

Augite-andesite from Kars.—The macroscopical aspect of this rock is that of a microcrystalline red-brown cavernous mass, in which to the naked eye are to be discerned minute porphyritically embedded augite crystals. Some of the cavities are filled up with secondary brown-iron ore, calcite and chalcedony. Under the microscope the ground-mass of this rock is found to consist partly of an exceedingly fine-grained crystalline aggregate of minute plagioclase columns and augite, and partly of glass base, to which is added a vast multitude of dark particles. The larger of the plagioclase individuals emerging out of this ground-mass constitute lath-shaped parts, lengthened in the direction of the brachy-diagonal axis, and usually polysynthetically twinned, according to the albite law. Frequently they are besides of a concentric-zonal structure. Several sections of these larger plagioclase individuals were examined as to their optical character, the results thereof being the values of the extinction-angles in the below-mentioned zones.

On measuring the extinction-angles on sections in zone PM (0P : ∞ P ∞) towards the twin-line of the lamellæ on each side of the said line, we obtained the following values :—

$$\frac{35°}{36°} : \frac{34°}{24°} : \frac{32°}{25°} : \frac{29°}{28°} : \frac{33°}{23°} : \frac{30°}{21°} : \frac{35°}{12°{\cdot}30}$$

When adding the values on each side of a twin-line thus obtained, we get the following figures :—

$$71° : 58° : 57° : 57° : 56° : 51° : 47°{\cdot}30.$$

Compared with the values arrived at by Michel-Levy[1] and Schuster[2] of

[1] Michel-Levy: *De l'Emploi de Microscope Polarisant, Ann. des Mines*, 1871.

[2] Schuster: *Optische Orientirung der Feldspathe, Tschermak's Min. Mitth.* Bd. III. 1880.

Digitized by Google

the angle between the extinction-directions in two plates contiguous to each other, these values seem to point to the existence of a plagioclase with a comparatively high percentage of lime.

In a plate intersected by a basal cleavage, the extinction on $\infty \breve{P} \infty$ is —32° towards the trace of $\infty \breve{P} \infty$ and $\infty P'$; a circumstance also holding good of Labradorite. Twin-streaked plates, according to the albite and pericline laws, are but very rarely met with.

The augite participates both in the construction of the ground-mass and in forming the porphyritic constituents. It has a pale green-yellow colour, which in the granules contained in the ground-mass assumes a darker tinge. The large porphyritic augite individuals are clear and translucent, having the shape of a short column, which in a cross-section manifests itself in a more or less uniformly hexagonal termination. The prismatic cleavage characteristic of the augite is frequently conspicuously marked.

Augite-andesite from Masgerth.—Macroscopically this rock exhibits a minutely granular brown-red mass, cavernously corroded on long exposed surfaces, in which augite crystals, 1 mm. in size and of bright green colour, are discernible to the naked eye.

When viewed under the microscope, the rock is found to be crystalline throughout. The finely granulated ground-mass is constituted by plagioclase and magnetite, decomposing into red oxide of iron. The porphyritic portions consist of plagioclase and augite. There is no trace of glass-base in the rock. Most of the plagioclase individuals, either merged in the ground-mass or porphyritically embedded in it, have the shape of a lath elongated in the direction of the brachydiagonal axis, and present an ordinary polysynthetic twin-formation, with a comparatively small angle between the extinction-directions on each side of a twin-seam. Several of them have, however, a more marked rectangular form, lack a polysynthetic twin-formation, and in their central core or nucleus as well as in their borders appear to be constituted by chemically different plagioclase substance. If the terminations of these probably basal sections are placed parallel with the principal sections of the crossed nicols, it will be found that the extinction-angle of the nucleus of the plagioclase individuals is a different one from that of their borders.

The following figures will demonstrate this :—

Border.	ext.	nucl.	ext.
,,	,,—8°	,,	,,—15°
,,	,,—6°	,,	,,—20°
,,	,,—7°	,,	,,—21°
,,	,,—7°	,,	,,—18°
,,	,,—8°	,,	,,—23°

Digitized by Google

This seems to suggest that the nucleus of these plagioclase individuals consists of some variation of plagioclase with a higher percentage of lime, possibly labradorite, whereas the surrounding matters are made up of a plagioclase with a lower percentage, and are perhaps andesine.

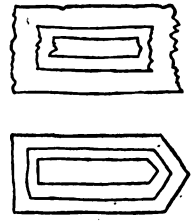


Fig. 3.

The plagioclase individuals contain included brown glass in great abundance, not unfrequently they are bent and broken into minute fragments.

The augite presents under the microscope the appearance of a wine-yellow colour, and shows scarcely any indication of pleochroism. On the other hand, the augite porphyritically embedded almost always occurs with well-defined terminations. Sometimes the augite is clear and free from any enclosed or attached particles. Sometimes, again, these accumulate in the augite in a vast profusion. Among these inter and juxtapositions, consisting partly of fluid cavities with air-bubbles and partly of magnetite (which evinces a great tendency to pass into red oxide of iron), the former are as a rule included in the central parts of the augite, whereas the latter partly in a narrow zone surround the borders or edges of the augite individuals, and partly group themselves in clusters about a larger or smaller portion of their sections. In the latter case, their profusion may sometimes assume such proportions as almost wholly to cover the augite, leaving it but in a few stray places or points to glimmer forth through the covering of the particles attached.

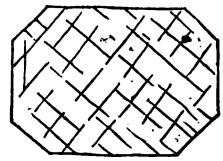


Fig. 4.

Obsidian from Kars.—This volcanic product appears in hand specimens black, is perfectly vitreous, and has a shelly fracture. Not the least indication of devitrification is microscopically to be detected.

In a prepared specimen there appears a variety of zone-like bands of almost exclusively pure glass substance; further, such a substance with enclosed minute colourless rod-like crystals ranged in the same direction, belonites; and finally the identical substance with hair-like black straight or geniculated inclusions, besides minute rounded black grains, trichites.

Fig. 5.

Digitized by Google

On a comparison of the Caucasian augite-andesites examined by Tschermak and Lagorio, it will appear that the rocks in question do not, like those from Elbrus and Kasben described by Tschermak, contain quartz, but belong to the group of quartz-free augite-andesites.

As has been done by Lagorio, they may further be divided into a pleocrystalline and a micro-crystalline group, the former of them being represented by the augite-andesite from Masgerth, and the latter by that from Kars.

Digitized by Google

On Granite containing Andalusite from the Cheesewring, Cornwall.

By J. J. H. Teall, M.A., F.G.S.

[Read May 10th, 1887.]

THE granite of the Cheesewring Quarry is coarse grained and grey in colour. It is essentially composed of white felspar, quartz and two micas. Tourmaline occurs sparingly. The dominant felspar is orthoclase, frequently twinned on the Carlsbad plan. Crystalline form is not well developed. Under the microscope the individual grains do not, as a rule, give definite extinction. Different portions extinguish at slightly different angles. The arrangement of the different portions is often very irregular; sometimes, however, it gives rise to a striped structure, under crossed nicols, suggestive of micro-perthite; but in no case has a perfectly definite intergrowth of plagioclase and orthoclase been observed. Examined by Szabo's method the orthoclase is seen to be fairly rich in soda. A well striated plagioclase occurs in the rock, but is present in very small quantity. When it does occur it is often seen to be idiomorphic with respect to quartz.

Quartz occurs abundantly in the form of large grains and also as a fine-grained aggregate of irregular individuals. It occasionally shows traces of crystalline outline. The two micas occur in thin plates without any great regularity of form. The dark mica is very strongly dichroic. Sections at right-angles to the basal plane change from a pale brown, when the cleavage cracks lie at right-angles to the short axis of the polariser, to a deep reddish brown (almost black) when the cracks lie parallel to the short axis. This mica is distinctly biaxial, but with a small optic axial angle. It contains inclusions of apatite and zircon. The zircon inclusions are in all cases surrounded by a border in which the colouring matter of the mica has been heaped up as it were. The apatite inclusions, on the other hand, are not surrounded by such a border. It is quite clear that the zircon inclusions have exerted an influence on the distribution of colouring matter in the mica, which the apatite inclusions have not.

The light coloured mica is not, at any rate as a rule, absolutely colourless; at the same time the colour is so slight as to escape notice in thin sections. It is biaxial, with a much larger axial angle than the dark mica. Where zircon inclusions occur in the white mica they are surrounded

Digitized by Google

by a pleochroic border of about the same width as the corresponding border in the black micas, but not nearly so dense. In the black micas the border is often quite opaque; in the white micas it is faint, but distinct.

Brown tourmaline occurs sparingly and presents no features of special interest. Minute crystals and grains of zircon are fairly abundant. Apatite occurs sparingly. In two or three of the slides examined there occurs another mineral of considerable interest. It possesses a higher refractive power than quartz, but about the same double refractive power. It occurs in more or less elongated crystals which often show a decided approach to crystalline form. Longitudinal sections are more or less lath-shaped, and generally without definite terminations. Cleavage cracks run parallel with the length of the sections. The major axis of the ellipse of elasticity invariably lies parallel with the length of the section. Hence we may infer that the direction in which the crystals are elongated is coincident with the a axis of elasticity—in other words, with the negative bisectrix. The lath-shaped or longitudinal sections often show a marked pleochroism; *a red*, *β* and *γ colourless* in thin sections. This pleochroism is never distributed uniformly throughout any one individual, but is developed in an irregular or patchy manner. Sections more or less at right angles to the direction of elongation show that the crystals are bounded by two pairs of parallel faces. Cleavages parallel with these faces may sometimes be detected, and the extinction-positions bisect the angles formed by the faces.

All the characters above described point to the conclusion that we are here dealing with somewhat ill-developed crystals of andalusite. The faces in the prismatic zone are those of the form {110}. In one slide a section cut almost at right angles to an optic axis was observed. The form of the section was that of a somewhat imperfect lozenge, the acute angle of which measured 69°. Assuming the mineral to be andalusite, having an optic axial angle of 84° (true), then the acute angle made by the traces of the prism-faces on a plane at right angles to an optic axis would be 74°2′. The difference between the observed and calculated results may be accounted for by the fact that the section is not exactly at right angles to the optic axis.[1]

The andalusite appears to have as good a claim to be regarded as an original constituent as any other mineral occurring in the rock. It may

[1] The optic axial angle of andalusite varies from 83° to 85° according to Rosenbusch. In Brooke and Miller (New Edition, 1852, p. 285) the half-angle is given as 46° 13′. If we assume that the above section is exactly at right angles to an optic axis, then it follows that the half angle must be 47° 22′, a result which agrees very closely with the statement in Brooke and Miller.

Digitized by Google

be seen in contact with unaltered felspar, and small crystals occur also as inclusions in white mica. In two of the slides examined there are nests exceptionally rich in dark mica and tourmaline. They contain also andalusite, quartz and a colourless mineral occurring in minute acicular prisms. The prisms are aggregated in bundles and sheaves, and occur as inclusions in a mineral having the refractive and double-refractive power of quartz.[1] They give straight extinction, and the γ axis is coincident with the length. They are cross-jointed at irregular intervals, and give chromatic polarisation between crossed nicols. These characters point to sillimanite. It is somewhat curious that two forms of SiO_2 Al_2O_3 should be present in the same rock. The andalusite gives rise by alteration to aggregates of white mica. This secondary mica, developed at the expense of the andalusite, is readily distinguishable from the normal white mica of the rock. I am indebted to Mr. Butler for the specimens on which the observations contained in this paper are based.

[1] It is possible that cordierite may be present.

Digitized by Google

Note on Francolite.

By F. H. Butler, M.A., A.R.S.M.

[Read May 10th, 1887.]

Some little confusion having apparently arisen with respect to the characters of certain Cornish apatites, it may be well in the interests of scientific exactitude to point out the following facts.—In a series of specimens of Francolite from Fowey Consols one may observe every gradation of form betwixt long and coarsely striated hexagonal prisms and narrow-edged crystals of an almost lenticular shape. Similar to the latter in their small vertical measurement are the "thin hexagonal plates" which have been enumerated among the known varieties of Cornish apatite, and which are, indeed, indistinguishable in general characters from the recently described Francolite of Levant Mine, St. Just. The particular Francolite, however, which, obtained by Mr. Talling from Fowey Consols, was shown by Maskelyne and Flight to contain over 5 per cent. of calcium carbonate (*Journ. Chem. Soc.* Jan. 1871), must not be identified with any one of the three varieties just mentioned. Carefully distinguishing it, in fact, from the ordinary Fowey Consols form, these authors write as follows:—

"The true francolite consists of small well-defined hexagonal prisms, usually terminated by the basal plane 111. The crystals of the variety under description consist of little aggregated crystals, in which the prisms intersect with each other in a confused manner, which may arise from their being twinned; but with such minute and rough tesselated surfaces it is impossible to determine the twin-plane. The prisms are terminated by a low pyramid, the faces of which form, with those of the prism $2\bar{1}\bar{1}$, an angle which an average of several measurements by the goniometer, with its object glass used microscopically, gave as 72° 47'." "The summit plane 111 seems, singularly enough, to be always absent, a not common feature in a true apatite."

The specimens now exhibited will serve to illustrate the above remarks, and to evidence the still unique character of the Francolite examined by the authors quoted.

Digitized by Google

Abstracts.

The Crystalline System of Braunite. Min. u. Petrogr. Mitth. vii. (1886), p. 443. Dr. Max Schuster concludes from a study of the braunite from Jakobsberg, Wermland, that the crystals from that locality belong to the rhombohedral system, and are tetartohedral and in all probability isomorphous with Hæmatite and Ilmenite; the chemical analysis leads to a formula which, expressed in the form $11MnO_3$, $3MnSiO_3$, is also in accordance with this result. H. A. M.

Albite from Kasbek.—This mineral, which has proved to be absolutely pure Albite free from all traces of potash and lime, was described by C. Bärwald (*Zeits. f. Kryst.* viii. p. 48), who determined its optical constants. The extinction-angles were found by him to be + 2° 19′ and + 17° 54′ upon the faces *P* and *M* respectively, and these values differ considerably from the values predicted for pure Albite by Max Schuster in his classical paper on the optical characters of the plagioclase felspars.

The latter author (*Ibidem*, p. 373) has re-examined this felspar, and concludes that Bärwald was misled by the twinning of the mineral, and that the true values are 4° 12′ and 18°44′ respectively, which are practically identical with his calculated values 4°30′ and 19°. H. A. M.

The Crystalline System of Descloizite.—With the help of Bertrand's new microscope Prof. Descloizeaux (*Zeitschr. f. Kryst.* xii. (1886), p. 178) has been able to see the system of rings in a plate normal to the acute negative bisectrix, and to ascertain that they belong without doubt to a rhombic crystal. H. A. M.

Sur le Granite à Amphibole de Vaugneray (*Vaugnerite de Fournet*); par Mm. A. Michel-Lévy et A. Lacroix. *Bull. d. l. Soc. Min. d. France*, Vol. X. (1887), p. 27. The rock in question forms a dyke about 400 metres thick in gneiss near Vaugneray, not far from Lyon. It was described by Fournet in 1836, under the name Vaugnerite. The authors show that it is merely a variety of hornblende-granite, and that it has therefore no right to a distinct name. It is dark in colour, and contains numerous scales of black mica. Green hornblende, white felspar and quartz may also be recognised by macroscopic examination. The elements

Digitized by Google

of the first period of consolidation are zircon, sphene, hornblende, biotite, labradorite, oligoclase, and orthoclase: those of the second period are orthoclase and quartz. Epidote and white mica are present as alteration products. The zircon is present as very minute quadratic crystals, and where it occurs as inclusions in the biotite and hornblende is surrounded by strongly pleochroic borders. Apatite is extremely abundant. The hornblende is elongated in the direction of the edge 100 : 010, and is frequently twinned parallel to 100. The lamellæ are often as numerous as in the plagioclase felspars. The pleochroism is feeble in thin sections; a, pale green; β, brown; γ, pale brown. In the pleochroic borders surrounding the zircon crystals rays vibrating parallel to a are emerald-green. The biotite is uniaxial and strongly pleochroic. It appears to be of later date than the hornblende. The labradorite occurs in crystals, and often shows zonal structure. Oligoclase is rare. Orthoclase is abundant, and often shows a kind of hazy twinning suggestive of microcline. It occurs as broken crystals, and also in plates, interfered with by the other constituents. Quartz is abundant, and is interfered with by the other constituents. It sometimes penetrates the felspar in vermicular infiltrations. Epidote arises in consequence of the alteration of the biotite. The white secondary mica is developed at the expense of the felspar. J. J. H. T.

Sur le Kerzanton de la Rade de Brest, par CHARLES BARROIS. *Ann. d. l. Soc. Géol. du Nord*, T. XIV. pp. 31-50.

THE rocks of the Rade de Brest, essentially composed of triclinic felspar and black mica, and worked under the name of Kerzanton, belong to two principal groups, the one characterised by a granular, the other by a porphyritic structure. The rocks of the former group are termed Kersantites, those of the latter mica-porphyrites (porphyrites micacées), by the author.

Kersantite may be described as a mica-diorite which is often rich in quartz and calcite. Felspar is the most abundant constituent; it occurs sometimes as whitish or greenish crystals, measuring some millimeters in length, but more frequently in very small grains forming a kind of felspathic matrix. The felspar with repeated twinning is oligoclase. It is generally more or less altered. Orthoclase, distinguished by the absence of twinning and by straight extinction in the zone 100 : 001, occurs in certain varieties of the rock.

Next to felspar a ferro-magnesian mica is the most important constituent. It occurs in prisms, sometimes measuring several millimeters in thickness. The outlines of basal sections may be irregular or hexagonal. In the

Digitized by Google

latter case they may be regularly hexagonal, or two of the opposite sides may be exceptionally developed. The mica is biaxial with a small optic axial angle. The axial plane is parallel to the two longest sides of the irregular hexagon (010). Sections normal to the base are strongly dichroic; they alternate with lamellæ of white mica and scaly chlorite. M. Barrois regards the white mica as a secondary product. Apatite is very abundant. Iron oxides are comparatively rare.

Quartz is present in variable quantity. Its aspect is that of the quartz of granites. Secondary quartz occurs in veins and geodes. Hornblende is sometimes present, sometimes absent. Augite occurs in many specimens. It is either colourless or a pale green. The prism faces are alone recognisable. It is often represented by a yellowish green alteration product.

The calcite is one of the most interesting constituents of the rock. It has been regarded as original by some writers. It occurs as irregular grains or in the form of pearls; each separate grain or pearl showing individual action under crossed nicols, and possessing the twin structure characteristic of the calcite in marbles. M. Rosenbusch has attributed the calcite to the decomposition of the constituent minerals of the rock. The author calls attention to the fact that calcite occurs in comparatively unaltered specimens. He supposes it to have been introduced into cavities and vesicles by percolating waters; the material having been derived from external sources.

Those varieties of kerzanton to which the author applies the term mica-porphyrite are distinguished from the kersantites above described by a more marked porphyritic structure. The elements of the first consolidation are apatite, black mica, oligoclase and pyroxene; those of the second consolidation are orthoclase, oligoclase, black mica, and iron ores. The secondary products include granular quartz, calcite, chlorite, white mica, hematite and pyrite. The matrix of the rock, composed of minerals belonging to the second period of consolidation, is essentially microlitic. The rocks are much altered. They are identical with the mica-porphyrites of Morvan described by M. Lévy, and with the kersantite-porphyrites of the Erzgebirge described by M. Kalkowsky and M. Rosenbusch. There is no hard and fast line between the kersantites and mica-porphyrites.

The dykes of kerzanton present two types of modification at their margins: (1) amygdaloidal, (2) micro-pegmatitic. The amygdaloidal type is found especially at the margins of thin dykes. The external zone of the amygdaloids is usually formed of chlorite, then follows a zone of chalcedonic or crystalline quartz, and the interior is occupied by calcite. The micro-pegmatitic type is more characteristic of the thicker dykes of kersantite. The matrix is in these cases a typical micro-pegmatite. Included

Digitized by Google

fragments of quartz, quartz-felsite, micro-granulite, and Devonian slate occur in the kerzantons of certain localities. They may be rounded or irregular in outline, and are generally separated from the rock by a coating of chlorite.

The rocks in question are certainly of later date than the lower carboniferous. Allied rocks occur in the upper carboniferous of Littry in Normandy, and it is probable, therefore, that the kerzantons of Brittany, like those of the Morvan and the Hartz, are of post-carboniferous age.[1]

About 50 dykes, varying from 1m. to 20m. in thickness, have been observed in the Rade de Brest. J. J. H. T.

Sur les Nodules de la Granulite de Ghistorrai près Fonni (Sardaigne), par M. Fouqué. *Bull. d. l. Soc. Min. d. France*, Tome X. (1887), pp. 57-63.

The mode of occurrence of these nodules has been described by M. Lovisato, to whom the author is indebted for the specimens which he has examined. They vary in size from that of a hazel-nut to that of one's fist. The rock in which they occur is a coarse-grained granulite, or as we should term it a granite. The constituents of the granite are orthoclase, oligoclase, quartz, biotite, and muscovite. The quartz occurs in large plates, and takes its form from the disposition of the adjacent minerals. The nodules are rounded but of irregular form. They may be readily taken for rounded pebbles. They may be easily detached by the hammer, and they leave a space coated with biotite. The majority of them possess a nucleus similar in every respect to the enclosing rock. Their external portions are formed essentially of albite and biotite. The albite is perfectly fresh. It is twinned according to the albite and pericline-plans. It occurs in plates representing sections of a truncated pyramid. The narrow bases are turned inwards and intimately united with the external surface of the nucleus; the broad bases are turned outwards and form a surface more regular than that of the nucleus. Each plate is formed of a number of individuals, which, however, are often similarly orientated, so that the boundaries of the individuals can only be distinguished by observing the distribution of the twin lamellæ. In the zone giving symmetrical extinctions the maximum double angle is 29°. Chemical tests revealed the presence of soda, and only traces of potash and lime. Hence the felspar is referred to albite or a microcline very rich in soda.

The biotite is arranged in concentric zones. The number of zones is variable, but sometimes reaches as many as eight or ten. The individual

[1] Similar rocks have been described by Mr. Collins from Cornwall (*Journ. Roy. Inst. Cornwall*, Part II. Vol. VIII. p. 30).

Digitized by Google

lamellæ are irregular, and mostly, though not invariably, arranged in a tangential manner with respect to the nodule. A plate of mica may sometimes be seen to lie in two differently orientated plates of felspar; hence the mica crystallised before the felspar. The biotite of the peripheral portions of the nodule is much fresher than that of the nucleus, or of the rock in which the nodules occur.

The relative size of the central and peripheral portions of the nodules is not constant. The nucleus predominates in the larger nodules. The diameter of the nucleus in such cases may reach two decimeters, the thickness of the albite-biotite border being only one centimeter.

One specimen examined appeared at first sight to be without a nucleus. It was found, however, that the central portions of this nodule consisted of a mixture of the constituents of the ordinary nuclei and those of the external zones.

It appears, therefore, that the nodules consist of two portions:—

(1) A nucleus formed of a fragment of the surrounding rock; and

(2) A marginal portion formed by concretion. The surface of contact of these two portions is more irregular than that of the nodule with the surrounding rock. J. J. H. T.

Beweis für den ursprünglich hyalin-magmatischen Zustand gewisser echten Granite und granitartige Gesteine. K. von Chrustschoff. *Neues Jahrbuch*, 1887, Band I. 208-211.

The author calls attention to the importance of the occurrence of glass-inclusions in the constituents of granite in relation to the theory that granite has originated from the consolidation of an igneous magma.

Zircon invariably belongs to the earliest period of crystalline development, and any inclusions which the zircons of granites may contain will therefore throw light on the condition of the granite-magma before any of the principal minerals of the rock had been formed. The following inclusions have been observed in zircons: (1) colourless belonites, (2) microlites of apatite, (3) smaller crystals of zircon, (4) opaque particles, (5) hollow spaces, (6) fluid inclusions, (7) glass inclusions, (8) needles of rutile.

The occurrence of glass inclusions with two or more bubbles, the forms of the bubbles sometimes showing distortion, have been observed by the author in the granite of Heppenheim in the Odenwald, the quartz-diorite of Weinheim, the Gabbro of Radauthal, the granite of Striegau, a granite-boulder from Markowka (South Russia), and a coarse-grained granite from the neighbourhood of Helsingfors. He remarks on the rarity of liquid inclusions in the zircons as compared with their abundance in the quartz.

Digitized by Google

The zircons were formed when the proportion of water to the liquid magma was small; the quartz, on the other hand, was formed when, owing to the separation of anhydrous minerals, the proportion of water was large. He regards the glass in the zircon-cavities as representing the original magma by the consolidation of which the granite was formed. J. J. H. T.

Beitrag zur Petrographie des Hererolandes in Sudwest-Afrika. Von Heinrich Wulf. *Min. u. Petrog. Mitth.* Band VIII. (1887), 193-238.

The specimens described in this communication were collected by Dr. Pechuël-Loesche in 1884. They are classified by the author as follows:—

I. Eruptive Rocks. (1) Granite; (2) Diorite; (3) Basalt.

II. Crystalline Schists. (1) Gneiss; (2) Mica-schist; (3) Diorite-schist; (4) Amphibolite; (5) Augite-gneiss; (6) Augite-schist; (7) Granular limestone.

III. Sedimentary rocks, minerals, and ores.

IV. Alteration products.

Granite.—This rock is extensively developed in the district, especially between Karibib and Otyimbingue. The dominant variety is a biotite-granite (granitite). Granite with two micas, hornblende-granite, and muscovite granite also occur. Coarse-grained varieties of muscovite-granite are represented in the collection. They are termed pegmatite by the author. The quartz of the granites contains liquid inclusions, and also numerous hair-like bodies. The finest of these appear opaque; the broader ones are colourless, and are referred by the author in part to sillimanite, and in part to apatite. The felspars include orthoclase, microcline, and oligoclase. Titanite is especially abundant in the hornblende-granites. The accessory minerals are magnetite, apatite, and zircon.

The dominant felspar of the pegmatites is microcline. This is often intergrown with albite. The quartz of the pegmatites is intergrown with felspar, as in graphic granite. Tourmaline occurs as a constituent of certain pegmatites.

Diorite occurs south of Karibib. It consists of plagioclase, hornblende, mica, quartz, and titanite.

Basalt. Felspar-basalt occurs in two localities; at Haikamehab and Husab.

Gneiss. The gneisses of the district resemble the granites in mineralogical composition, except that muscovite-gneiss has not been recognised.

Digitized by Google

Microperthitic intergrowths of orthoclase and microcline with albite or oligoclase-albite were observed. Fibrolite-gneiss is recorded from Sievenberg, sixteen kilometers east of Otyimbingue. Zircon frequently occurs as inclusions in the biotite, and is always surrounded by a border in which the pleochroism is more marked than in the rest of the section. Apatite inclusions in the same mineral are not surrounded by a pleochroic border.

Mica-schist.—This rock is recorded from several localities. A specimen from New Barmen contains macroscopic garnets. Another from a point 5 kilometers west of Pot contains biotite with inclusions of zircon and rutile. A staurolite-bearing mica-schist occurs between Okahandya and Otyosazu. The main mass of the rock is fine grained, but the staurolite crystals are commonly 1 c.m. in length. The pleochroism of the staurolite crystals is very marked; γ = reddish brown, β or γ = yellow.

Diorite-schist.—The author includes under this head certain medium grained hornblende-bearing schists which contain a considerable amount of oligoclase. They contain plagioclase, hornblende, biotite, titanite, quartz and apatite.

Amphibolite.—This rock is distinguished from the diorite-schist by the abundance of quartz, and by the fact that felspar plays a subordinate part in the composition of the rock. It is also of finer grain.

Augite-gneiss.—This is in many respects the most interesting rock described by the author. It is essentially composed of augite, felspar and quartz; scapolite and wollastonite, however, frequently take the place of felspar. A good example of augite-scapolite-gneiss occurs at the copper mine on the Tsoachaub. The scapolite is without crystalline outline. Sections parallel to the direction in which the individuals are elongated show parallel cleavage cracks and give straight extinction. Sections nearly but not quite at right angles to this direction show two sets of cleavage cracks intersecting approximately at right angles, and the extinction position in these sections makes very nearly an angle of 45° with the cleavage cracks. This points to the conclusion that the perfect cleavages are parallel to {110} and not to {100} as is generally stated to be the case. Sections exactly at right-angles to the two cleavage directions remain dark between crossed nicols and give in convergent light the figure of a uniaxial mineral with negative double refraction. The double refraction of the scapolite is stronger than that of either felspar or quartz, and is, of course, most marked in sections parallel to the vertical axis; that is, in sections in which the cleavages are represented by parallel lines. The

Digitized by Google

scapolite contains no fluid inclusions, but inclusions of hematite (eisenglimmer) are common. Epidote is occasionally seen in the scapolite, and especially near the junction of scapolite and augite. The iron in the epidote is probably supplied by the latter mineral. The scapolite is attacked by concentrated HCl. The mineral was isolated by the Sonstadt solution and furnished the analysis quoted below.

The augite of this rock shows marked pleochroism, the colours varying from yellowish green to dark green. Its extinction angle in sections parallel to (010) is 47°. Its composition is quoted below. The felspar of this rock is referred to albite by the author. Quartz occurs sparingly. Apatite and muscovite are accessory minerals.

A scapolite-augite-gneiss occurs at Husab. It differs from the rock above described in containing more scapolite than augite and a greater percentage of quartz and felspar. At the same locality occurs a rock rich in microcline and containing augite and titanite. Associated with this rock is another consisting for the most part of garnet and augite—a kind of eklogite. Specimens illustrating the transition from scapolite-bearing augite-gneisses to others in which scapolite is absent occur in the collection. The felspar of these rocks is either labradorite or anorthite.

The wollastonite-augite-gneisses alternate with the scapolite-augite-gneisses to which they are closely related. The wollastonite is elongated in the direction of the ortho-diagonal, or it may occur in a tabular form with conspicuous development of the ortho-pinakoid. More or less lath-shaped sections frequently give straight extinction, in consequence of the fact that the individuals are elongated in the direction of an axis of elasticity. Double refraction strong. Twinning as in ordinary monoclinic pyroxenes (twin plane 100) is very common. Cleavages parallel to (001) and (100). Optic axial plane at right-angles to the direction of elongation. A rock from Reed is composed of wollastonite, scapolite, augite, titanite and garnet. A very remarkable mineral association is represented by a rock from the copper mine. This rock consists essentially of wollastonite and a grass-green diopside. The analyses of both minerals are quoted below.

Augite-schist.—This is represented by a single specimen from the plateau north of the Tsoachaub. It is a fine-grained dark-green rock containing quartz, augite, hornblende, felspar, magnetite with zones of titanite and apatite.

Granular limestone. This rock occurs interbanded with the schists. Five kilometers west of Pot it is associated with mica-schists, and it occurs under similar conditions at a point five kilometers east of Husab.

Digitized by Google

It is sometimes a pure limestone, at other times it contains accessory constituents, such as olivine, usually serpentinised, mica, and augite. In one case the author observed intergrowths of primary and secondary calcite resembling micro-pegmatite [? Eozoon structure. *Abst.*]

The sedimentary rocks included in the collection comprise a reddish quartzite, a dark grey and a white compact limestone. The minerals comprise specimens of epidote (see below) and specimens of copper ores similar to those described by A. Knop. Under the head of decomposition products the author refers to an arkose cemented by carbonate of lime, and to the sand of Walfisch Bay. The latter consists principally of quartz, but contains also felspar, augite, magnetite, garnet, zircon, epidote, titanite, rutile, hornblende, and tourmaline.

The petrographical work embodied in this Paper was executed in Prof. Zirkel's laboratory at Leipzig.

	I.	II.	III.	IV.	V.	VI.	VII.
SiO_2 ...	52·62	53·24	48·23	49·25	51·18	51·62	37·04
Al_2O_3 ...	26·42	25·60	2·78	5·78	1·08	1·85	22·99
Fe_2O_3 ...	tr.	tr.	—			—	14·19
FeO ...	—	—	18·75	—	—	13·03	—
MnO ...	—	—	tr.	—	—	tr.	tr.
CaO ...	13·11	12·83	22·82	42·48	47·65	24·81	24·09
MgO ...	—	—	6·43	0·93	—	9·54	—
Na_2O ...	6·62	7·03	1·40	—	—	—	—
K_2O ...	0·45	0·47	—	—	—	—	—
Cl ...	0·10	0·12	—	—	—	—	—
SO_3 ...	0·79	0·66	—	—	—	—	—
Loss ...	0·45	0·50	—	—	0·42	—	2·16
	100·54	100·45	100·36	98·44	100·33	100·40	100·47
Sp. Gr.	2·683	2.682	3·37	2·81	2·864	3·33	3·40

I. Scapolite from the augite-scapolite-gneiss occurring near the copper mine. The analysis agrees approximately with the formula $Me_1\ Ma_1$ according to Tschermak's theory.

II. Scapolite from the scapolite-augite-gneiss of Husab. The analysis corresponds approximately with the formula $Me_9\ Ma_{11}$.

III. Augite associated with the scapolite whose composition is represented in I.

IV. Wollastonite of the augite-gneiss from Reed.

V. Wollastonite of the wollastonite-diopside rock from the copper mine.

VI. Diopside from the same rock.

VII. Epidote crystals. J. J. H. T.

Digitized by Google

Ueber Chloritoidschiefer von Grossarl. Von A. Cathrein. *Min. u. Petrog. Mitth.* Band VIII. (1887), 331-337.

The author describes the petrographical characters of a boulder found near St. Johann, in the Grossarlthal. Macroscopically the rock consists of rounded groups of chloritoid scales about 1 mm. in diameter, lying in a fine-grained yellowish-white groundmass. The lamellæ of chloritoid are grouped in sheaves and bundles. Sometimes they are arranged so as to resemble a double fan. Isolated scales of chloritoid are very rare. Basal sections are rare. They are bluish green in colour and irregular in outline. Lath-shaped sections show a marked pleochroism, the colour changing from yellowish to bluish-green. Under crossed nicols the scales are seen to be composed of two or more thin lamellæ, the basal-plane being the face of composition. This mode of twinning is characteristic of the minerals of the ottrelite group. The lath-shaped sections often show oblique extinction. When the extinction positions of adjacent lamellæ are symmetrical with reference to the trace of the face of composition, the extinction angle referred to this trace is 14°. The groundmass of the rock is composed of quartz, rutile and leucoxene (titanite).

Chloritoid is soluble in dilute sulphuric acid, and the author utilised this property for the purpose of determining the composition of the mineral.

		I.	II.	III.
SiO_2	...	25·50	92·82	26·17
TiO_2	...	1·88	6·93	—
Al_2O_3	...	38·69	—	40·38
FeO	...	27·19	—	26·41
CaO	...	0·40	0·76	—
MgO	...	0·08	—	0·08
H_2O	...	6·67	—	6·96
		100·41	100·51	100·00

I. Portion soluble in dilute sulphuric acid (67·26 per cent.), containing all the chloritoid and small amounts of titanite, rutile and iron ore.

II. Portion insoluble in dilute sulphuric acid (33·06 per cent.), consisting of quartz, rutile and a small amount of titanite.

III. Composition of the chloritoid as deduced from a consideration of analysis I.

A discussion of the analyses leads the author to the conclusion that the rock consists of 63·98 per cent. of chloritoid, 30·16 per cent. of quartz, 4·03 per cent. of rutile and ores, 1·83 of titanite. It differs from the chloritoid-bearing rocks described by Renard, von Foullon and Schröeder in the amount of chloritoid, in the absence of micas, and in the fact that it

Digitized by Google

does not possess the aspect of a phyllite. It is a true chloritoid-schist, whereas the rocks containing chloritoid which have been previously described are chloritoid-phyllites, chloritoid-mica-schists, and chloritoid-calcite-schists. J. J. H. T.

The Nature and Origin of Lithophysæ and the Lamination of Acid Lavas. By J. P. Iddings. *Amer. Jour. Science*, Vol. XXXIII. Jan. 1887.

The rhyolitic obsidian of Obsidian Cliff, in the Yellowstone National Park, is especially remarkable for the extent to which spherulitic structures have been developed. The spherulites posses a radially fibrous and sometimes also a concentric structure. They vary in size from microscopic dimensions to several inches in diameter. In chemical composition they resemble the glass in which they occur. Under the microscope they are seen to be composed of sections of crystalline fibres. The individual fibres do not give straight extinction, and consequently the spherulites do not show a fixed black cross[1] when examined under polarised light. Such spherulites as those described are connected by transitional forms with granophyric [micropegmatitic] intergrowths of quartz and felspar. Trichites and microlites occur in the spherulites and also in the granophyric aggregates. The fibres of the largest felspars are composed of microscopic felspar crystals, and between these fibres are scales of tridymite, grains of magnetite, microlites and gas cavities; thus in the smaller spherulites and in the centre of the large spherulites the silica is present as quartz; in the marginal portions of the larger spherulites it is present as tridymite. Yellow iron-olivine or fayalite, apparently of later origin than the felspar, occurs in the porous spaces of the larger spherulites. The larger spherulites are frequently hollow. The hollow space may lie near the circumference or may occur in the interior of the spherulites. The fibres project into the hollow spaces. Several cavities arranged in a concentric manner may sometimes be observed. In the laminated lavas the layers of microlites may be followed through the spherulites. The large hollow spherulites are generally hemispherical. They constitute the lithophysæ of von Richthofen. The mineral constituents of the lithophysæ are quartz, tridymite, felspar, fayalite and magnetite. The felspar in some cases has the crystal habit of adularia, in others it is tabular. It is described by the author as a soda-orthoclase corresponding to a mixture of one molecule of orthoclase with one of albite, and having an asymmetric character. The fayalite has been previously described in the *American Journal of Science* for July 1885.

[1] They are the pseudo-spherulites of Rosenbusch.

Digitized by Google

The author summarises the views held by various writers as to the origin of lithophysæ. Some writers regard the lithophysæ as original structures developed in connection with the consolidation of the lava; others regard them as the result of the decomposition of solid spherulites. The lavas of the Yellowstone region are wonderfully fresh, and he considers, therefore, that the latter view is incorrect so far as these are concerned. He holds that considerable light is thrown on the origin of the lithophysæ by the experiment of Daubrée on the effect of super-heated steam on glass, by those of Friedel and Sarasin on the artificial production of orthoclase, albite, quartz and tridymite, and by those of von Chrustschoff on the production of quartz and tridymite. The obsidian of Obsidian Cliff contains 0·66 per cent. of volatile matter, mostly, in all probability, water, and is converted into a kind of pumice by heating in the oxy-hydrogen flame. That the lithophysæ were developed before final consolidation is proved by the fact that when crushed, as sometimes happens, the obsidian may be seen to penetrate for some distance into the cavity. He concludes that the lithophysæ and the minerals associated with them "are of aqueo-igneous origin, and have been produced by the action of the absorbed gases upon the molten glass from which they were liberated during the crystallisation consequent upon cooling." He imagines the formation of a lithophysa to have been somewhat as follows. "In the still plastic glass from a centre of crystallisation a multitude of incipient microlites of felspar radiated through a sphere of glass. As these anhydrous microlites increased in size the nature of the cementing paste was changed. Being impoverished of alumina and alkalies it became more siliceous and relatively more hydrated. A point was reached where the absorbed vapours could no longer be retained in combination, but were released in innumerable bubbles, which were either uniformly disseminated through the paste or aggregated into larger bubbles. The gas thus liberated acted as super-heated steam, and eventually produced the separation and crystallisation of all the elements of the original sphere of plastic glass."

The author next discusses the origin of the laminated structure so characteristic of many acid lavas. This structure is well developed in the lithoidal portion of the obsidian flow which forms Obsidian Cliff. The different layers vary in colour, density and degree of crystallisation. The more crystalline layers are full of minute cavities, and are consequently planes of weakness along which the rock may be split into plates sometimes measuring only $\frac{1}{16}$th of an inch in thickness. He points out that rhyolitic lavas are more viscous and less uniform in composition at the

Digitized by Google

time of eruption than basic lavas, and that the laminated structure is the natural result of the deformation of a mass of lava of somewhat variable composition as it takes the form of a flat sheet on a more or less horizontal surface. The views of the author as to the origin of the laminated structures are the same as those long ago arrived at by Mr. Poulett Scrope.[1]

J. J. H. T.

Optical Anomalies of Crystals.—The never-failing discussion of the optical anomalies of crystals is continued by R. Brauns (*Neues Jahrb.* 1887 (I.), p. 47), who combats the assertion of Mallard (*Min. Mag.* VII. (1886), p. 46) that sudden cooling does not produce internal strains in a crystal as it does in glass, but causes the former either to crack or to develop twin lamellæ; the author finds, on the contrary, that crystals of rock-salt, sylvine and fluor cautiously heated and then suddenly cooled in oil, become doubly refracting and behave exactly as glass of the same form under the same conditions; and that both rock-salt and glass which have been so treated lose their double refraction when heated, only to acquire it again when cool. Brauns maintains accordingly that internal strains are produced in isotropic crystals by sudden cooling, and that they are the sufficient cause of the optical anomalies. H. A. M.

Methylene Iodide in Mineralogy.—Brauns (*Neues Jahrb.* II. (1886), p. 72) recommends this liquid both as a specific gravity liquid for separating minerals and also as a highly refracting medium for determining indices by the method of total reflection. Its specific gravity, 3·33, is greater than that of Thoulet's solution, and the variation in the same is very constant, for slight changes of temperature it is reduced to any desired point by dilution with Benzole.

The index of refraction is 1·7487 at 5° (sodium light), the decrease is uniform for equal increments of temperature, and the dispersion diminishes as the temperature increases.

The liquid is not decomposed or diluted by exposure, and is easily purified by shaking it up with diluted potash water. H. A. M.

Celestine from Lüneburg (*Zeits. f. Kryst.* Vol. XI. p. 220) is the subject of a paper by C. Hintze which has special reference to the study of "vicinal faces." The mineral occurs as granular-crystalline masses in a light-grey marl, and the cavities are lined with small bright crystals shown by analysis

[1] Notice on the Geology of the Ponza Isles. *Trans. Geol. Soc.*, London, 2nd Ser. Vol. II. p. 195.

Digitized by Google

to be pure strontium sulphate. The dome faces $\breve{P}\infty$ {101} and $\frac{1}{2}\breve{P}\infty$ {012}, and the basal plane are accompanied by vicinal faces with very complicated indices, which occur, however, with the same regularity which characterises the vicinal faces of Danburite as established by Max Schuster (see this Magazine, VI. p. 213). In the case of Celestine, Hintze suggests that this regularity may be as well indicated by the direct differences of angle as by the variations of parameters. It is certain that many more observations are required before the nature of vicinal faces can be understood, and that there is great danger of arriving at a hasty conclusion in a matter which is beset with so many difficulties. H. A. M.

Digitized by Google

THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

No. 35. DECEMBER 1887. Vol. VII.

On a Meteoric Iron seen to fall in the District of Nejed, Central Arabia, in the year 1863.

By L. Fletcher, M.A., F.C.S., President; Keeper of Minerals, British Museum; late Fellow of University College, Oxford.

[Read May 10th, 1887.]

In 1885 a trustworthy Persian agent, through whom various antique objects had been already acquired for the British Museum, offered for sale to its authorities a so-called thunderbolt, weighing 131 lbs. (59·4 kilograms), and submitted at the same time the following translation of a Persian letter from his Excellency Hajee Ahmed Khane Sarteep, Ex-Governor-General of Bunder Abbas, Persian Gulf, and Grand Vizier of Muscat:—

"Bushire, dated 14th Di Koodah, 1301.

"Received on the 7th October, 1884.

"In the year 1282 after the death of Mahomed, when Mame Faisale Ben Saoode was Governor and General-Commander-in-Chief of the Pilgrims, residing in a valley called Yakki, which is situated in Nagede, in Central Arabia, Schiekh Kalaph Ben Essah, who then resided in the abovenamed valley, came to Bushire, Persian Gulf, and brought a large thunderbolt with him for me, and gave me the undermentioned particulars concerning it.

Digitized by Google

"'In the spring of the year 1280, in the valley called Wadee Banee Khaled, in Nagede, Central Arabia, there occurred a great storm, thunder and lightning being particularly prevalent; and during the storm an enormous thunderbolt fell from the heavens, accompanied by a dazzling light, similar to a large shooting star, and it embedded itself deeply into the earth. During its fall the noise of its descent was terrific. I, Schiekh Kalaph Ben Essah, procured possession of it, and brought it to you, it being the largest that ever fell in the district of Nagede. These thunderbolts, as a rule, only weigh two or three pounds, and fall from time to time during tropical storms.'

"The above concludes the narrative of Schiekh Kalaph Ben Essah.

"I myself saw in Africa four years after the above date a similar one, weighing 136 pounds, to that which Schiekh Kalaph Ben Essah brought to me, and the Sultan of Zanzibar, Sayde Mayede, obtained possession of it and forwarded it to Europe for the purpose of having it converted into weapons. For this reason I have forwarded my thunderbolt to London (as when melted and made into weapons they were of the most superior kind and temper), considering it one of the wonders of the world, and may be a benefit to science.

"The said Schiekh Kalaph Ben Essah, who brought me this thunderbolt, is still alive, and under Turkish Government control at Hoodydah, near Jeddah.

"Yours truly,

"(Signed) HAJEE AHMED KHANE SARTEEP."

As the mass presents characters identical with those of undoubted meteoric irons, the genuineness of the account given in the above letter is almost beyond criticism: the *naive* remark that Nejed thunderbolts as a rule only weigh 2 or 3 lbs. should convince the most sceptical that intentional deceit is here out of the question.

The mass is thus one of the small group of meteoric irons, numbering at most nine or ten, of which the fall has been actually observed; and of these it is the largest.

The first day of the year 1280 of the Mahommedan Calendar corresponds to June 18th, 1863, of our reckoning.

The mass is rudely tetrahedral in shape: its length is 16 inches (41 cm.), and the breadth and thickness are both about 11 inches (28 cm.). The surface is completely covered with pittings, similar to those of the Braunau and Johnson County irons; such pittings are often shown by the meteoric stones. There is no evidence of weathering, and on the greater part of

Digitized by Google

the surface the thin black crust of magnetic oxide of iron formed during the passage through the air is visible.

Relative to water at 4°, and allowing for displaced air, the specific gravity at 23° C. of a thin slice weighing 6·0859 grams was determined to be 7·863 (uncorrected 7·89).

Relative to a solution of copper sulphate, the iron is active, the reducing action having visible results after two minutes from the beginning of contact.

The iron is soft, and is easily cut with a hack-saw. During the preparation of some thin slices, small enclosures both of graphitic carbon and of troilite were met with, and present the usual characters: no stony matter was apparent.

On the large polished face, in addition to some smaller enclosures of troilite, there is one having a breadth of 3 mm. and a length of 9 mm.: several cracks starting from it are filled with the same material.

When etched with bromine-water the polished surface displays excellently the Widmanstätten figures: the beams of kamacite are straight and long, and are sometimes uninterrupted for a distance of three or four centimeters: on a section so taken that the beams form approximately equilateral triangles, their thickness averages about 0·8 millimeters. In the groups of parallel beams of grey kamacite extremely thin layers of intervening bright tänite are visible. The remaining plessite, which is very similar to the kamacite in its appearance, shows the fine parallel ridges ("combs") mentioned by Reichenbach. Large patches of the etched face have an orientated sheen. The etched section is very similar to that of Verkhne Udinsk: the figures are as well-defined as those of Toluca, but the beams of kamacite are longer, more even in thickness, and form larger groups, while the plessite is less striking.

When treated with warm dilute hydrochloric acid a fragment of the iron containing no visible enclosures yielded a black insoluble residue consisting chiefly of amorphous graphitic carbon: the last parts to dissolve were small thin bright metallic plates, of which some at least were enclosed by the carbon. Iron, nickel, cobalt, and copper were the only metals found in the solution: from an as yet unfinished examination of a photograph of the spectrum of the electric arc between poles of this iron, Professor Lockyer infers the presence of traces of titanium, aluminium, manganese, barium and calcium.

On analysis of the filings obtained during the levelling of the large

Digitized by Google

section, the following numbers were obtained by the methods already described,[1] and give as the average composition of the mass :—

	Nejed.	*Trenton.*	*Toluca.*	*V. Udinsk.*
Iron	91·04	91·03	90·74	91·05
Nickel ...	7·40	7·20	7·78	8·52
Cobalt ...	0·66	0·53	0·72	
Copper ...	trace	trace	0·03	—
Phosphorus ...	0·10	0·14	0·24	trace
Sulphur ...	trace	—	0·03	trace
Insol. Residue	0·59	0·45	0·34	0·58
	99·79	99·35	99·88	100·15

The black residue insoluble in *aqua regia* consists chiefly of amorphous carbon; when heated on platinum foil it begins to smoke, and afterwards takes fire, burning with a luminous flame: it contains a trace of chromite, which gives a green colour to a bead of microcosmic salt.

In chemical composition the Nejed iron is very similar to Trenton, as determined by Lawrence Smith,[2] to one of the masses from the Toluca Valley, as determined by Pugh,[3] and also to Verkhne Udinsk, as determined by Kotschubei.[4]

---

[1] *Min. Mag.* 1887, Vol. VII. p. 124.
[2] *Amer. Jour. Sc.* 1869, Series 2, Vol. XLVII. p. 271.
[3] *Annal. der Chem. und Pharm.*, 1856, Vol. XCVII. p. 385.
[4] *Zeitsch. d. deutsch. geol. Gesell.*, 1864, Vol. XVI. p. 356.

Digitized by Google

On a Meteoric Iron (containing Crystallised Chromite) found about the year 1880 in Greenbrier County, West Virginia, U.S.A.

By L. Fletcher, M.A., F.C.S., President; Keeper of Minerals, British Museum; late Fellow of University College, Oxford.

[Read October 25th, 1887.]

A SINGLE fragment of iron, having an estimated weight of eleven pounds, was found about the year 1880 on or near the top of Alleghany Mountain, 8 miles north of White Sulphur Springs, Greenbrier County, not far from the eastern border of West Virginia, U.S.A.; this corresponds to longitude 80° 20′ W. of Greenwich, latitude 37° 51′ N. The finder and his official agent, thinking it a piece of rich iron ore, searched unsuccessfully for a vein: the specimen itself was taken to a country smith's shop, heated and cut with a cold chisel; the pieces were distributed as specimens of iron ore. Some time afterwards, two of them, weighing respectively 63 oz. and 31 oz., were given by the agent to Mr. Matthew A. Miller, Civil Engineer, of Richmond, Virginia; convinced of their meteoric origin, he immediately tried to recover the pieces already distributed, but after travelling several hundred miles was forced to the conclusion that they were irrecoverably lost. From Mr. Miller the two pieces were acquired for the British Museum.

In shape they are irregular: each of them presents clear evidence of being fragmentary, the surface being partly smooth and pitted, and partly jagged, the latter showing in a remarkably distinct way edges, faces, and crevices which belong to an octahedral structure.

Relative to water at 4°, and allowing for displaced air, the specific gravity at 17°·2 C. of a thin slice, free from rust and weighing 11·0552 grams., was found to be 7·869 (uncorrected 7·89).

Relative to a solution of copper sulphate, a polished surface of the iron is immediately active.

The iron is extremely soft, and was easily sawn into slices.

On the polished faces of these no stony minerals are visible, but there are seen sections of a few rounded cavities, of which the contents have a greyish-black colour and a metallic lustre; this material is principally finely divided iron which has perhaps been worked into the cavities during the sawing of the specimen, and the subsequent levelling of the surface; the rest is graphitic carbon, which may have been sufficient to fill the cavities when the specimen was intact. No chromite was found in the cavities.

Digitized by Google

During the polishing of one of the sections a part of its surface was bent inwards, and there was found to be an empty cavity with plane faces: the quadrilateral lid of the cavity is 6 mm. long and 3 mm. wide: three of the edges of the section of the cavity were seen to be parallel to structural lines visible on the polished surface even before etching: the sides of the cavity were rusty. Similar cavities are shown by the iron from Rancho de la Pila, Durango, Mexico.

After treatment with bromine-water a polished face shows very distinct Widmanstätten figures. On a section not very much inclined to an octahedral face the beams of kamacite have a thickness varying from 0·8 to 1·2 mm.; they have straight edges, are in groups, and are sometimes uninterrupted for a length of 17 mm. They are separated by very thin layers of lustrous tänite. The remaining component, the plessite, is plentiful, but is very homogeneous in structure, and not very different in appearance from the kamacite. There is no orientated sheen, such as is presented by the etched surfaces of many meteoric irons. The figures approximate to those on one of the slabs of an iron from Staunton, Virginia, U.S.A., now shown in the British Museum: to this also it is very similar in its percentage composition, as pointed out later.

A fragment of the iron, presenting no visible enclosures, and weighing 1·6 grams., yielded a trace of sulphuretted hydrogen when warmed with dilute hydrochloric acid. Iron, nickel, cobalt and copper were found in the solution. The small black insoluble residue was evidently composite, for part of it was only slightly more dense than the solution, and remained for a time in a state of suspension, while the rest, after disturbance, quickly settled to the bottom of the flask. The former material was doubtless graphitic carbon; the latter, when washed and dried, was seen to consist of (1) a fine powder, (2) small fragments, (3) a thin elongated plate, and (4) a single opaque black crystal with bright faces and a metallic lustre.

The crystal was found to be very fragile, for it broke when pushed gently with a platinum wire. Some of the fragments of the crystal were faintly attracted by a bar magnet. The largest fragment was measured on the reflective goniometer, and found to present five of the faces of a regular octahedron: in addition, there are two narrow faces which give images; one of them is a face of the dodecahedron, and the other corresponds in position to a face of the form {221}: the angle (111·221) was measured to be 15°39′, the calculated angle being 15°48′. This fragment is a little more than a millimeter in diameter. Another fragment of the crystal was found to be insoluble in aqua regia, and imparted

Digitized by Google

a beautiful green colour to a bead of microcosmic salt. Another fragment was found to be incombustible and infusible. Hence we may infer that the crystal is doubtless chromite.

Microscopic crystals of this mineral occur in the meteoric stones, and minute crystals were found by Maskelyne[1] in the siderolite of Breitenbach; in the meteoric irons, however, the existence of crystallised chromite has up to the present not been completely established. The only instance appears to be one recorded by Shepard:[2] in the insoluble residue of the iron of Seneca River, Shepard found two octahedral crystals, weighing together $\frac{1}{200}$th of a grain, and presenting the octahedral form and the lustre of chromite: in the absence of further crystals no examination for chromium was made.

The fragility of this crystal of chromite is of some interest, as showing clearly that easy frangibility of a crystallised material, generally difficult to break, is in itself no proof of pseudomorphism: it will be remembered that the crystals of graphitic carbon obtained from the Youndegin iron possessed this character. Maskelyne has likewise directed attention to the fact that some of the rounded crystals of asmanite enclosed in the siderolite of Breitenbach are extraordinarily brittle on their surfaces, and often fly into fragments even with the most careful handling.

The fine powder, small fragments, and the thin elongated plate, were likewise found to be essentially chromite.

Phosphorus was found in the insoluble residue, and was present probably as phosphide of iron and nickel.

For the quantitative analysis 5·0789 grams. of the filings obtained from a large section of the iron were dissolved in aqua regia, and the following percentage composition was obtained by methods detailed in a previous paper:[3]—

	Greenbrier Co.	*Trenton.* (L. Smith.)	*Rio Juncal.* (Damour.)	*Seneca River.* (Shepard.)	*Staunton.* (Santos.)
Iron	91·59	91·03	92·03	92·12	91·44
Nickel	7·11	7·20	7·00 }	7·54	7·56
Cobalt	0·60	0·53	0·62 }		0·61
Copper	trace	trace			0·02
Phosphorus ...	0·08	0·14	0·21	0·08	0·07
Sulphur	trace				0·02
Residue	0·12	0·45		0·26	0·14
	99·50	99·35	99·86	100·00	99·86

[1] *Philosophical Transactions*, 1871, Vol. CLXI. p. 359.
[2] Amer. Jour. Sc. 1853, Ser. 2, Vol. XV. p. 365.
[3] *Mineralogical Magazine*, 1887, Vol. VII. p. 124.

Digitized by Google

In another experiment made to determine the copper and sulphur, 9·4364 grams. of the filings were treated with dilute hydrochloric acid, and the evolved gas was passed through bromine-water to which some hydrochloric acid had been added: the sulphur was found to be only 0·007 per cent. and the copper 0·01.

The above percentage composition is approximately that of the Trenton,[1] Rio Juncal,[2] Seneca River, and Staunton[3] irons, as shown in the adjacent columns.

---

[1] *Amer. Journ. Sc.*, 1869, Ser. II. Vol. XLVII. p. 271.
[2] *Comptes Rendus*, 1868, Vol. LXVI. p. 569.
[3] *Amer. Journ. Sc.* 1878, Ser. III. Vol. XV. p. 337.

Digitized by Google

On Crystals of Cuprite and Cerussite resulting from the slow alteration of buried coins.[1]

By L. Fletcher, M.A., F.C.S., President.

THE coins referred to in this paper were received through Professor J. W. Judd, F.R.S., to whom they had been sent by Mr. George W. Shrubsole, F.G.S., Honorary Curator of the Museum belonging to the Chester Society of Natural Science.

According to Mr. Shrubsole the Roman coins of Chester are generally found in soil consisting more or less of disintegrated red sandstone and clay: the coins of the find now under consideration must have been buried for fifteen centuries, for such as have been deciphered belong to what is called the Roman Third Brass, and range from Philippus, A.D. 244, to Constantine, A.D. 337. Mr. Shrubsole further remarks that crystals are not found to result from the alteration of isolated coins; when met with they line cavities between adjacent coins of a pile. And this ought, perhaps, to be expected. The water which trickles through the soil and contains dissolved carbonic acid and alkaline carbonates will convert into carbonate all metallic copper to which it has free access: a single coin or a pile of coins will thus, in the course of time, be covered with a more or less protective crust of carbonate of copper: within the crust, however, the action will be that of water rather than carbonic acid, and the material will be changed to oxide. But, while in the case of an isolated coin there is no internal cavity in which crystals have space for their development, in a pile such cavities will be produced through the thrusting asunder of adjacent coins by the formation of intervening carbonate near the rim.

The products of alteration noticed in these coins are blue and green carbonates of copper (chessylite and malachite), red oxide of copper (cuprite), and yellow carbonate of lead (cerussite).

The blue and green carbonates are uncrystallised.

The red oxide of copper is often distinctly crystallised; one cavity contains some transparent cubo-octahedra and cubes of great splendency; they are nearly a millimeter in thickness.

[1] These products of alteration were exhibited at the meeting on October 20th, 1885.

Digitized by Google

The carbonate of lead, though rarely seen, is in one cavity present as a little tuft of yellow acicular crystals.

This mode of occurrence of carbonate of lead has been remarked by Lacroix:[1] the Roman coins examined by him were found in Algeria, and were those of the time of Severus, A.D. 205-234: one of the coins was analysed by him with the following result:—

Copper	...	79·76
Lead	...	16·26
Tin	...	3·97
		99·99

On the same coins from Algeria were cubes of cuprite; they showed no replacement either of their edges or quoins.

Cuprite is often found as a result of alteration of long buried objects of bronze. Small transparent octahedra were found on breaking fragments which had formed part of the leg of a gilded bronze horse found in the Saône, near Sainte Claire, in 1766: red crystals were also observed in a similar object found in 1771 (or 1777) in the city of Lyon, and were proved by Sage to be chemically identical with the Cornish mineral cuprite discovered just before.[2] Buffon, however, thought that the red crystals were really an arsenic compound.[3] Nöggerath describes dodecahedra and cubo-octahedra of cuprite as results of alteration of a Roman vessel dug up at Wichelshof near Bonn in 1818-9:[4] in this case the vessel might have been subjected to the action of fire.

Copper coins dug up from Torre del Greco after the Vesuvius eruption of 1794 had been converted into red oxide: and crystals were found on a brass candlestick.[5] The red oxide has been met with as a furnace-product; and, after the great fire of Hamburg, copper objects were found to have been changed to the same oxide.[6]

---

[1] *Société Minéralogique de France*, 1883, Vol. VI. p. 175.

[2] *Observations sur la Physique, sur l'Histoire naturelle et sur les Arts*, par Bozier et Mongez, 1779, Vol. XIV. p. 155.

[3] *Histoire naturelle des Mineraux*, 1785, Vol. III. p. 56.

[4] *Das Gebirge in Rheinland Westphalen*, 1824, Vol. III. p. 231.

[5] *Schweigger's Journal für Chemie und Physik*, 1825, Vol. XLIII. p. 132. *Breislak's physische und lythologische Reisen durch Campanien*, 1802, p. 204.

[6] *Erdmann's Journal der Chemie*, 1840, Vol. XIX. p. 118. *Hausmann's Beiträge zur metallurgischen Krystallkunde*, 1850, p. 17. *Leonhard, Hütten-Erzeugnisse*, 1858, p. 365.

Digitized by Google

On the Crystalline Form of Creatine.

By L. Fletcher, M.A., F.C.S., President.

[Read May 10th, 1887.]

SOME small crystals of a substance, supposed at the time to be an allotropic modification of Creatinine ($C_4H_7N_3O$), were submitted to me for crystallographic determination. The crystals of which the angles were to be measured were thin elongated plates nearly $\frac{1}{10}$th of an inch long, $\frac{1}{100}$th of an inch broad, and $\frac{1}{500}$th of an inch thick.

Although so minute, the crystals were found to give very sharp images, and measurement of four of them led to the following results:—

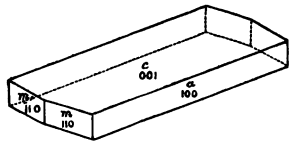
System.—Monosymmetric.

Elements.—$a : b : c = 2{\cdot}404 : 1 : 2{\cdot}479$; $\beta = 71°8'$.

Forms observed.—$a\{100\}$, $c\{001\}$, $m\{110\}$: and, on one crystal, also $e\{201\}$.

The faces of the form e are narrow, and replace the edges ac, $\bar{a}\,\bar{c}$.

The crystals are elongated parallel to the axis of symmetry, as illustrated in the accompanying figure.



Angles.	Mean.	Limits.
ac	71°8′	70°54′–71°13′
$c\bar{a}$	108°52′	108°48′–109°3′
ae	21°38′	21°38′
am	66°16′	66°11′–66°28′
mm'	47°28′	47°25′, 47°29′
mc	82°31′	82°30½′, 82°31′
$\bar{m}c$	97°29′	97°23′, 97°37′

Almost accidentally, it was observed that these angles were strikingly similar to the following angles assigned by Heintz[1] and Keferstein[2] to creatine ($C_4H_9N_3O_2$):—

[1] *Pogg. Ann.* 1848, Vol. LXXIII. p. 595.

[2] *Ibid.* 1856, Vol. XCIX. p. 294.

Digitized by Google

	Heintz.	Keferstein.	
	Mean.	Mean.	Limits.
ac	71°5′	70°41′	69°43′—71°54′
am		65°49′	
mm′	46°50′	47°50′	46°48′—49°32′

The crystals of supposed creatinine were accordingly submitted to a chemical examination, and were found to be actually creatine.

As so few crystals of this substance have been measured, and the last recorded measurements were made thirty years ago, the above confirmatory numbers are worthy of record: they serve at the same time to illustrate the fact that the goniometer is still of service as a discriminating instrument.

The angles given by Heintz were obtained from a single crystal, the only one he was able to find from which satisfactory measurements could be got: those given by Keferstein were the results of measurement of five crystals.

We may add that the parametral ratios generally assigned to creatine and creatinine in works on chemistry are wrongly calculated; in each case the number assigned to the ratio $a : b$ should be divided by the corresponding value of sin β.

Digitized by Google

On a Variety of Glaucophane from the Val Chisone (Cottian Alps).

By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

[Read October 25th, 1887.]

AS I was descending the Val Chisone from the Col de Sestrières last summer, my eye was attracted by the peculiar colour of an erratic, which was lying on the hillside very near the road. The violet-blue tint, generally indicating the presence of glaucophane, was perceptible, especially in certain lights, but, as it was much less strongly marked than in rocks in which I had previously observed the mineral, I felt doubtful. However, I secured a good specimen, and now find on microscopic examination that glaucophane is present, though it is a pale coloured variety, differing from those which I have hitherto examined.[1]

The block was a fairly large one, perhaps more than a square yard in area, and a couple of feet thick. I did not, however, take measurements, as the exact size was unimportant. There was no like rock visible in the neighbourhood for a considerable distance, so that I cannot say whether it had been brought down from the upper part of the Val Chisone, or along the line of a small gully from somewhere on the mountain above. Time did not permit me to attempt a search for the parent rock, which would certainly have occupied hours, and it might be days. The erratic is very near Fresnières, in the Commune of Pragelas.[2]

The rock was tough and difficult to break. The specific gravity is 3·10.[3] It is holocrystalline, rather fine-grained, and, on examination with a lens, appears composed of a dark purplish-coloured, a green, and a whitish mineral, the last being the least abundant. There is a slight, but only a very slight, approach to a foliated structure, such as may be seen in certain diorites which have been modified under pressure subsequent to their original consolidation.

Microscopic examination shows that the constituents are not now in their original condition. The principal are the glaucophane, a rather dirty-

[1] *Min. Mag.* Vol. VII. p. 1, and p. 150.

[2] The nearest locality on record, so far as I know, is the Val di Lanzo, where pebbles of glaucophane rock were found near Germagnano. *Williams, N. Jahrb.* 1882, Bd. II. p. 201.

[3] Kindly determined for me by Dr. Plimpton, in the University College Laboratory.

Digitized by Google

looking yellowish-green mineral, and some felspar. The glaucophane occurs abundantly in transparent flakes, like those of chlorite, or needle-like actinolite, often about ·01″ by ·0015″, and frequently grouped in slightly diverging bundles. It has, in short, an actinolitic habit; cross sections showing the characteristic cleavages of hornblende are rare. The tints are pale, but there is a distinct dichroism; the long sections changing from a pale violet-blue, with vibrations parallel with the vertical axis, to a barely perceptible bluish-grey, with vibrations perpendicular to it. Transverse sections afford a moderately strong violet tint with vibrations parallel with the orthodiagonal axis, and with those perpendicular to it an extremely faint purplish or reddish-grey tint, being almost colourless. With crossed nicols the extinction angles in longitudinal sections are small, as is usual with glaucophane.[1] With ordinary light these sections exhibit a distinct though pale violet-blue tint, while a cross section is much paler, but more distinctly purple in its tint.

The yellowish-green mineral has a dirty look, as if full of dust, and so is difficult to examine. Its external form is not very definite. It often exhibits traces of a close platy cleavage, and reminds me of an altered diallage, while in other grains two cleavages may be observed, which occasionally resemble those of hornblende, but more often seem to cross at high angles as in augite. Locally we get a little green hornblende associated with this mineral. Its dichroism is very feeble, the extinction angles are inconstant, generally suggesting a hornblende, but occasionally large enough for an augite. After careful study of the mineral, I am of opinion that it was once an augite (probably aluminous), but has undergone considerable alteration. In many cases a platy structure has been set up. Further change has caused the separation of a constituent—probably the aluminous silicate—in very minute microliths, and a process of 'uralitization' has converted the remainder more or less completely into a variety of hornblende. Felspar (species indeterminable) can now and then be recognised, and there are many small grains in the slide which are probably this mineral or some alteration product. A grain or two of epidote is probably present, and I think I recognise a little quartz. There are also many small patches and granules, clustered or single, brownish or greyish, more or less opaque or earthy looking. Of the former, some may be a kaolinitic residue after felspar; others, decomposition products after an iron-oxide—perhaps in part ilmenite.

The glaucophane is generally in close relation with the uralitic mineral,

[1] *Lasaulx, Précis de Petrographie, s.v. Glaucophane.*

Digitized by Google

often bordering it or even apparently in crystalline continuity with it. I cannot doubt that the glaucophane is a secondary product in the rock. The structure of this has been greatly obscured by subsequent molecular changes, but the arrangement of the uralitic mineral suggests that the original structure was more or less 'ophitic.' I believe, then, that the rock was once a dolerite, consisting chiefly of a felspar, such as labradorite, and an augite (probably a variety rather rich in alumina). The formation of an actinolitic variety of hornblende in dolerites and gabbros is a mode of change in these rocks with which we have now become familiar. In this case, however, I imagine that some of the constituents of the augite entered into combination with the soda constituent in the adjacent felspar, and produced along the border line an actinolitic glaucophane instead of an ordinary actinolite. Thus, by the molecular rearrangement of the constituents of an aluminous augite and labradorite, has resulted a glaucophane and (probably) a felspar akin to anorthite.

Digitized by Google

On a Specimen of Proustite containing Antimony.

By H. A. Miers, M.A., F.G.S., and G. T. Prior, B.A.

[Read October 25th, 1887.]

THE specimen which is the subject of the present note is a magnificent piece of Proustite from Chañarcillo, Chili, which has been recently acquired for the British Museum. It is a mass of lustrous crystals, measuring about 3 inches by 2½ inches, and nearly 3 inches in height.

The specimen has a peculiar cockscomb appearance, due partly to the habit of the crystals and partly to the way in which they are grouped; the lower part consists of Proustite, interpenetrated by a little minutely crystalline white Calcite, which on one side of the specimen extends partly over the crystals in the form of darker coloured acute rhombohedra.

The larger Proustite crystals have the aspect of rough triangular pyramids, with blunt apices and a ragged outline due to the smaller crystals which protrude along their edges.

The forms present are *e*, $\{110\}$, $-\frac{1}{2}R$; *s*, $\{11\bar{1}\}$, $-2R$; *v*, $\{20\bar{1}\}$, $R3$; *P*, $\{32\bar{3}\}$, $-2R\frac{3}{2}$.

In the larger crystals the faces *s* are prominent and form the blunt apex, while the lower parts are drusy and uneven and composed of the forms *P* and *v*, with curved faces of steep scalenohedra and prisms; on these crystals the form *e* only makes its appearance as linear planes, which traverse the faces of *s* and give rise to step-like projections upon them.

The smaller crystals, on the other hand, have the usual scalenohedral habit due to the predominance of *v* and are terminated by *e*, below which is the form *s* in oscillatory combination with *e* and truncating the acute edges of the scalenohedron *v*.

Intermediate between these two habits are some on which *s* and *P* are the predominating forms, although the terminations consist of *e* faces in superposed lamellæ.

The faces of *e*, *s*, *v* and *P* are all very bright; *v* is striated parallel to the lateral edges of the primary rhombohedron $\{100\}$ *R*; *P* has curved striæ nearly parallel to its intersections with *s*; the striæ upon *e* parallel to *s* and *e*, and those upon *s* parallel to *e*, are due to oscillatory combination; the faces themselves are smooth.

Digitized by Google

The smaller crystals are invariably grouped upon the larger in twin position according to the two laws, (1) twin planes {211} $\frac{1}{2}R$: (2) twin planes {100} R. There are no doubly terminated crystals.

Except for the variations in habit the whole specimen appears to be homogeneous throughout, and has the aspect of ordinary Proustite.

Measurements (Miers).—The crystals best suited for measurements are those of scalenohedral habit, in which both the rhombohedra *e* and *s* have perfectly smooth lustrous faces. The angle between the *e* faces must be used to determine the exact form in preference to any other angle, since minute differences in the element of a rhombohedral crystal will make themselves more evident in the angles of flat rhombohedra and faces near the summit of the crystal than among such as lie near the prism zone, where the angular values are the same for all such crystals.

Three of these crystals (*A B C*) were measured with the following results, in which e_1 e_2 e_3 denote the three faces of $-\frac{1}{2}R$ which terminate each crystal.

		A	B	C
e_1 e_2	...	42°44′53″	42°45′50″	42°45′43″
e_2 e_3	...	42°45′57″	42°45′50″	42°46′23″
e_3 e_1	...	42°46′50″	42°46′33″	42°46′27″
Mean	...	42°45′53″	42°46′4″	42°46′11″

Final mean ee=42°46′3″

A fourth crystal, upon which the faces *s* were particularly well developed, gave the following values:—

s_1 s_2 = 99°21′13″
s_2 s_3 = 99°21′43″
s_3 s_1 = 99°21′50″
Mean ss = 99°21′35″ observed.
99°21′50″ calculated from ee.

In all the above measurements each angle is the mean of three observations, and may be regarded as reliable to about 15″.

The angle of the primary rhombohedron R {100}, calculated from the value ee = 42°46′3″, is 72°12′4″.

It is clear then that the rhombohedron angle of these crystals may be taken as 72°12′ within very close limits.

Analyses (Prior).—Two analyses were made: in analysis A material taken from the underside of the specimen was used, while analysis B was made on the four crystals actually measured, together with other small and

Digitized by Google

perfect crystals of precisely the same appearance all taken from the upper part of the specimen.

The material used in analysis A, although taken from the underside of the specimen, was crystalline, and when examined for adhering and enclosed impurities under the lens and during the process of crushing, seemed to be perfectly homogeneous and to all appearance true Proustite.

In both analyses the mineral was decomposed in a current of chlorine: the volatile chlorides of sulphur, arsenic and antimony were absorbed by a mixture of hydrochloric and tartaric acids, while the silver was left in the residue as chloride. The solution containing the arsenic and antimony was evaporated down to a small bulk with constant addition of potassium chlorate, and was then treated for the separation of the arsenic and antimony.

In analysis A this separation was effected by Fischer's method as modified by Hufschmidt, which consists in reducing the arsenic to arsenious acid by means of a ferrous salt, and then distilling off the arsenic trichloride in a current of hydrochloric acid gas. The arsenic in the distillate was precipitated by sulphuretted hydrogen as trisulphide, which was washed with water, alcohol and carbon bisulphide, dried and weighed. The antimony was also precipitated by sulphuretted hydrogen, and the resulting trisulphide, after being washed with water and dried, was heated to $260° - 270°$ in a current of carbonic acid.

In analysis B the separation of the arsenic and antimony was effected by magnesia mixture. In order to free from magnesium tartrate, the precipitate of ammonium magnesium arsenate was dissolved in hydrochloric acid and reprecipitated with ammonia and a little magnesia mixture: finally it was converted into magnesium pyroarsenate. The antimony in the filtrate was precipitated in cold solution by sulphuretted hydrogen as pentasulphide, which was washed with water, alcohol and carbon-bisulphide, dried and weighed.

In both analyses the sulphur was determined in a separate portion of the powdered material by fusion with potassium nitrate and sodium carbonate, and precipitation of the sulphate with barium chloride: the resulting barium sulphate, after being weighed, was warmed with dilute hydrochloric acid according to the method of purification given in Fresenius, *Quant. Anal.*, §132.

Below are the results of the analyses, together with—

α theoretical composition of true Proustite.

β ,, ,, ,, Pyrargyrite.

Digitized by Google

A′ theoretical composition of a mixture of 83·64 p.c. of Proustite and 16·36 p.c. of Pyrargyrite.

B′ ,, ,, of a mixture of 93·82 p.c. of Proustite and 6·18 p.c. of Pyrargyrite.

	A	A′	B	B′	α	β
Silver ...	64·50	64·50	65·06	65·06	65·40	59·90
Arsenic...	12·54	12·69	13·85	14·23	15·17	—
Antimony	3·62	3·65	1·41	1·38	—	22·31
Sulphur	19·09	19·16	19·64	19·33	19·43	17·79
	99·75	100·00	99·96	100·00	100·00	100·00

Weight of material used in analysis A { For determination of Ag, Sb and As ... 0·7158 gr. / For determination of S 0·4924 ,,

Weight of material used in analysis B { For determination of Ag, Sb and As ... 0·9102 gr. / For determination of S 0·3834 ,,

Specific gravity of the crystals used in analysis B = 5·638.[1]

Results.—Our results may be briefly expressed as follows:—

Rhombohedron angle.	Percentage of As.	Percentage of Sb.	Spec. Grav.
72°12′	13·85	1·41	5·64

The only analyses hitherto made together with crystallographic measurements are those recently published by Rethwisch (Neues Jahrbuch, Beilage Band IV. (1886) p. 31). His results expressed in the same way are:—

	Rhombohedron angle.	Percentage of As.	Percentage of Sb.	Spec. Grav.
Proustite	72°10′10″	15·03	—	5·5553
	71°22′27″	3·01	18·63	5·716
	71°21′30″	2·62	18·58	5·754
Pyrargyite	71°12′58″ [2]	—	22·36	5·871

[1] The above value is the mean of numerous determinations taken with all possible precautions on 2·5 grams of material by means of the specific gravity flask. The results varied considerably, the limits being 5·617—5·676. In our opinion the value of the specific gravity determined with the flask from such a small weight of material cannot be relied upon beyond the first place of decimals.

[2] This angle is liable to the objection indicated above, since it is determined from the measurement of the scalenohedron v, $R3$, $\{20\bar{1}\}$; the above value is calculated from the angle $vv = 35°10'47''$. Now an angle of 35°11′51″ would correspond to the rhombohedron angle 71°22′0″, and the measurements were certainly not reliable within one minute.

Digitized by Google

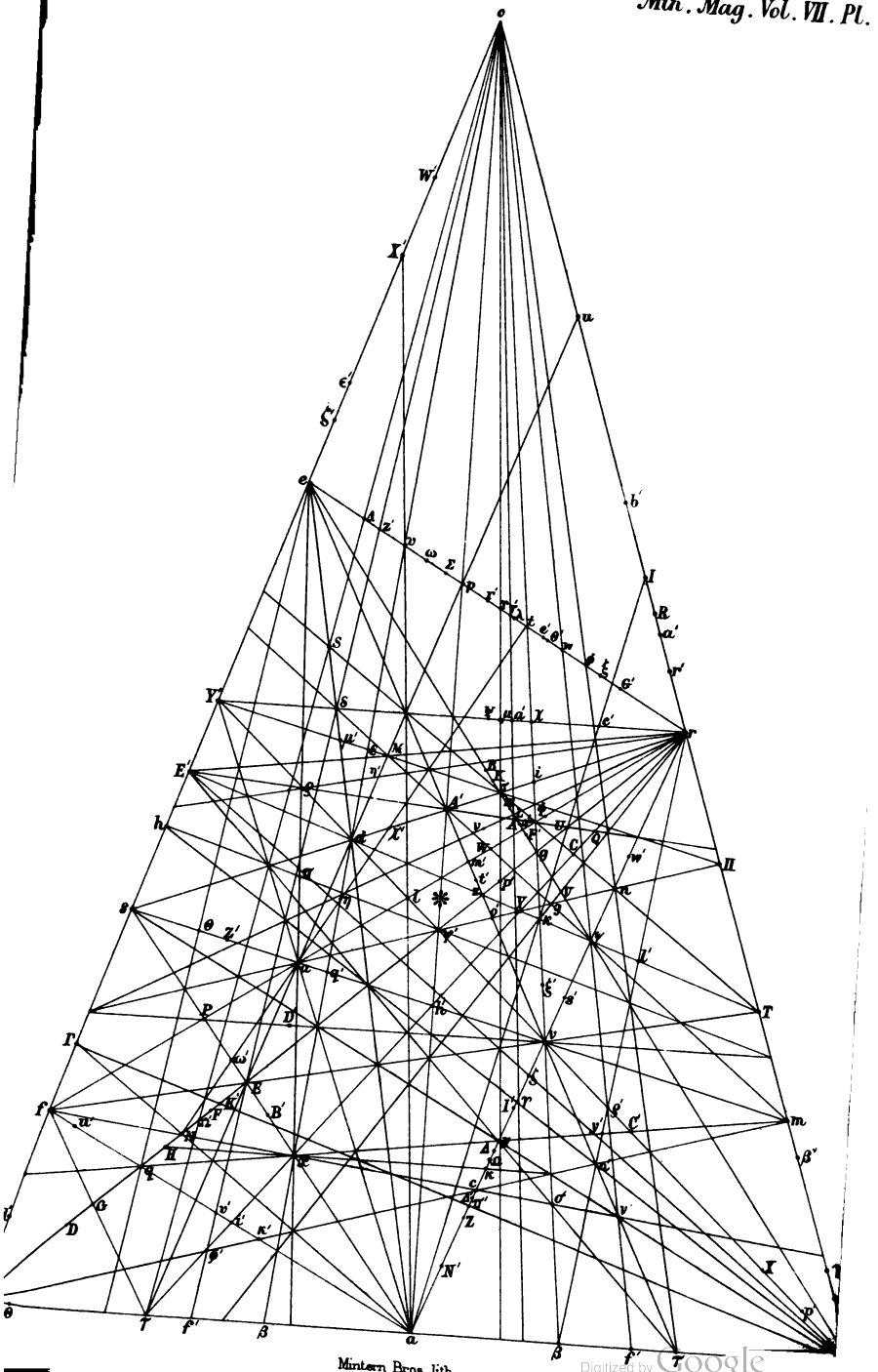
We have found the rhombohedron angle on some crystals of Proustite from Chañarcillo which are free from any trace of antimony to be 72°11′50″; that is to say, within the errors of observation, absolutely identical with the angle of Proustite containing more than 1 per cent. of antimony; and it will be seen that our crystals have no place in the series which Rethwisch professes to have established.

It may be remarked that Rethwisch does not say whether the material analysed by him consisted of the crystals actually measured; the present analyses show that this is a matter of great importance, since in our specimen, which has all the appearance of being homogeneous, the crystals measured contain 1 per cent., while another part contains 3 per cent. of antimony.

Conclusions.—The analyses prove that the antimony is very unevenly distributed throughout the specimen, and is probably present in smaller quantities in the better crystallised parts; it is even conceivable that the surface of the crystals may contain no antimony; but, however that may be, it is certain that *in the crystals here analysed the presence of more than 1 per cent. of antimony has no appreciable effect upon the rhombohedron angle.*

Whether this is always the case, or whether there are varieties intermediate in form as well as in composition between true Proustite and Pyrargyrite, can only be decided by the examination of a large number of specimens, a task upon which we are now engaged, the results of which, it is hoped, will be shortly published.

Digitized by Google



Mintern Bros. lith.

Digitized by Google

Digitized by Google

On the Occurrence of Rutile-needles in Clays.

By J. J. H. Teall, M.A., F.G.S.

[Read October 25th, 1887.]

THE discovery by my friend, Mr. Dick, of zircon, rutile, tourmaline, cyanite, &c., in the Hampstead and other sands,[1] and also the necessities of a work in which I am engaged, have induced me within the last few weeks to turn my attention in a somewhat systematic manner to the sedimentary rocks, and especially to the clays. At present I have examined only eight or nine samples of clays, but I have already come across a fact which I trust will be thought of sufficient interest to justify this communication. In examining the clays the method I adopt differs from that followed by Thurach in his classic investigations, "Ueber das vorkommen mikroskopischer Zirkone und Titan-Mineralien in den Gesteinen,"[2] only in one respect. I examine the washings which are removed by his process. The method is as follows:—The dry clay is roughly pounded up in a mortar, and the powder thus formed is placed in a sieve having 70 or 80 meshes to the inch. The sifting is effected under water in a porcelain basin. After most of the material has passed through, the sieve is removed, the water in the basin is agitated, and the turbid water is decanted. The process is repeated until only the clean grit remains. This grit contains quartz, felspar, and the heavy minerals zircon, tourmaline, rutile in orange and yellow crystals or grains, cyanite, pyrite, &c., when these are present. An average sample of the grit is examined both in water and when mounted in balsam, and also a sample from which the lighter materials have been roughly separated by vanning. The turbid water poured off during the first operation is allowed to settle in a beaker for about a minute, and then samples are taken by means of a glass tube from the top and bottom of the turbid portion.

Now I find amongst the finer material of certain clays a large number of extremely minute acicular crystals. These appear like short black bristles when examined with a low power, but under a high power and when mounted in balsam they are generally seen to be transparent and

---

[1] *Nature*, Vol. XXXVI., p. 91.

[2] *Verh. d. phys.-medic. Gesellschaft zur Wurzburg. Neue Folge.* Band xviii.

Digitized by Google

nearly colourless; the blackness is evidently due to a marked difference between the refractive indices of the needles and the balsam. Some needles are so thin as to be dark under a very high magnifying power: these, however, are rare. The finest needles are less than ·001 mm. in thickness; but on the average their thickness is about ·002 mm. As a rule they are from 8 to 15 times longer than broad, but sometimes they are as much as 80 times longer than broad.

Under crossed nicols the thicker needles give colour, and even the thinnest on which any observation can be made produce a marked depolarising effect. They extinguish straight in all cases, and the minor axis of depolarisation (in this case an axis of elasticity) lies parallel with the length of the crystal. Assuming the mineral to be uniaxial, this shows that its double-refraction must be positive.

The above facts are sufficient to render it highly probable that we are here dealing with rutile, and this is rendered certain by the occurrence of the characteristic twins. Rutile frequently occurs twinned, so that the principal axes of the two individuals make angles of either 65° 35′ or 54° 44′ (Rosenbusch). Now both these types of twinning have been observed several times in the needles from the clays. The angles measured do not deviate more than one or at the most two degrees from the above values, and this deviation is well within the limits of experimental error. Sometimes, though rarely, the twinning is seen to be of a complex character, suggesting the sagenite aggregates of De Saussure.

The needles in question are similar to those which have been recognised by so many observers as occurring in the clay-slates, and which are generally termed clay-slate-needles (thon-schiefer-nädelchen). They were first described by Zirkel,[1] and subsequently identified as rutile by Werneke,[2] Cathrein,[3] and Sauer.[4]

Their occurrence in the clays is therefore by no means surprising; and I should not have described them so minutely were it not for the fact that their apparent absence from the clays has been commented upon. Thurach states that he has not found them in the ordinary sedimentary rocks; but this is easily accounted for, as they are carried away with the finer material during the process of washing, and he does not appear to have examined this material. I am not prepared to say that they are

[1] *Pogg. Ann.* 1871, cxliv. 319.
[2] *Neues Jahrb.* 1880, ii. 281.
[3] *Ibid.* 1881, i. 169.
[4] *Ibid.* 1881, i. 227.

Digitized by Google

present in all clays, and they certainly vary in abundance in those specimens which contain them. In some they are extraordinarily abundant, in others they are comparatively rare. The needles must not be confused with the larger crystals and grains of rutile which are often so abundant in the finer sands and clays. The latter are probably as distinct in origin as they are in character from the former. I will now give a brief account of the mineralogical character of those clays in which I have observed the needles. The ill-defined substance (or substances) generally termed kaolin forms of course in each case the bulk of the clay. This will not be referred to.

The measurements appended will give a general notion of the sizes of the constituents.

Pipe-clay from the Bagshot Beds, Alum Bay, Isle of Wight.—Quartz grains; diameter of average grains about ·013 mm. Prisms of tourmaline sometimes terminated at one end by the faces of a rhombohedron and at the other by the basal plane, thus showing the characteristic hemimorphism; ·012 × ·02 and ·012 × ·046. Grains (·08) and crystals (·01 and ·06) of zircon. Anatase in octahedra; ·003 + ·01. Rutile-needles abundant, sometimes showing characteristic twins.

Sandy Kimmeridge Clay, Drayton.—A large number of microscopic nodules of pyrites, exactly similar in form and appearance to the well-known larger nodules; average size ·07 mm.; largest observed ·2 mm. zircon grains and crystals; ·13 × ·06 and smaller. Tourmaline. Rutile in grains and crystals; same size as zircon. Anatase in pyramidal (.02 × ·01), and also in tabular (·034 × 044) form. Cyanite in cleavage flakes (·16) giving extinction referred to trace of second cleavage of 28° and showing a negative bissectrix in convergent light. Rutile-needles scarce.

Sandy Clay containing Plant Remains from the Shaw Kiln, Newbury.—Quartz grains. Zircon in crystals, sometimes capped, and grains. Rutile in grains (·05), individual crystals and twins. Tourmaline. Black grains. Rutile-needles comparatively scarce.

Plastic Clay, Newbury.—Nodules of ferric oxide evidently pseudomorphous after pyrites-nodules similar to those described above. Quartz. The heavy minerals, zircon, tourmaline, &c., comparatively rare. Rutile-needles and twins.

Thames Mud at Kew.—Quartz grains. Zircon crystals and grains. Tourmaline. Several undetermined minerals. Many individuals and

Digitized by Google

species of diatoms. Rutile-needles scarce. The abundance of diatoms suggests that these organisms may contribute an important amount of silica to certain argillaceous deposits.

Silurian Clay, Rubery Asylum, Lickey Hill, Worcestershire.—Quartz grains. Tourmaline. Zircon crystals and grains (rare). Black grains. Pyramidal anatase in very minute crystals. Rutile-needles both single and twinned.

In conclusion, I have to state that I am indebted to my friend, Mr. Jukes Browne, and also to Mr. Bennet, for several of the specimens above referred to.

Digitized by Google

On the Nature and Origin of Clays: the Composition of Kaolinite.

By J. H. Collins, F.G.S.

[Read October 25, 1887.]

THE clays appear under many widely different aspects, and from one point of view must be studied as rocks. There are rock-masses alike of clay and of serpentine, both the result of important metamorphic processes. The basis, however, of most—probably of all—clays appears to be a substance of definite composition and well-marked characters, as much entitled to specific mineral rank as allophane or serpentine, or perhaps opal. In this paper I propose to consider clay as a rock and as a mineral.

1. *Clay as a rock.*—The kaolinisation of felspar, the incipient stage of which is indicated simply by a peculiar opacity, as in the case of the granitic rocks of Cornwall and West Devon, is sometimes very complete, and occurring over large areas results in the shape of kaolin or China-clay, or potter's and brick-clay. Such productions may be conveniently studied according as they occur *in situ* or are derived and transported.

a. Clay-masses in situ.—The chief of these is the rock known as China-clay-rock or *Carclazyte*,[1] composed of white or greyish-brown quartz, white lepidolite or gilbertite, and white orthoclase, the last more or less completely kaolinised. As accessories, schorl and brown mica (lepidomelane) are common, and cassiterite and topaz not rare. The form of the felspar crystals, often clearly distinguishable, is usually the Carlsbad macle. The China-clay-rock seldom extends more than a few fathoms on either side of the schorlaceous veins in which kaolinisation seems always to have originated, but may accompany them to a depth of 100 fathoms or more from the surface. Several of the largest China-clay works in Cornwall—as at Carclaze and Beam—were at first opened on such veins for the tin they contained.

"China Stone," or Petuntzyte,[2] is a rock similar to but less completely altered than Carclazyte, its usually abundant felspar retaining some alkali.

---

[1] J. H. Collins, F.G.S., 1878. The Hensbarrow Granite District.

[2] *Hensbarrow Granite*, p. 31. This substance is ground up with clay and other ingredients in the manufacture of porcelain.

Digitized by Google

There is often a little fluor present, and the presence of white lepidolite ("shell"), and brown or black schorl may detract from or neutralise the economic value of the rock. In the parishes of St. Stephen's and St. Dennis, near St. Austell, and at Tregoning Hill, in Mount's Bay, China-stone, like the China-clay-rock, occurs in irregular bands or patches. Though as yet never worked more than a few fathoms from the surface, it is believed to continue in depth. In several localities it overlies China-clay, which it very rarely caps.[1]

The kaolinisation noticeable in the "decomposed elvans"—mostly altered felsites, quartz-porphyries, or felspar-porphyries—affords excellent material for crucibles and fire-bricks, but is practically useless as a source of China-clay.

b. Derived Clay.—Of these the following may be taken as typical examples:—

(1.) *Flucans of Mineral Veins.*—These commonly observable unctuous clay-partings or vein-fillings are among the most common phenomena. They are the product of former continued earth movements, or a sediment from fluids.

(2.) *Bovey Tracey Clay Deposits.*—These beds, interstratified with lignite, by their situation at the base of the extensively kaolinised granitic rocks of Dartmoor, suggest a derivation from those rocks by a process of natural clay-washing into a depression then occupied by a lake. The pipe-clay and potter's clay of Dorsetshire have had a somewhat similar origin.

(3). *London Clay.*—The abundance of the foreign matter in this clay is plainly due to the distance of its place of origin from that of its deposition. Mr. Sorby's remark that "the chief portion of the fine-grained clays cannot be distinguished from the products of the decomposition of felspars and other minerals which can be changed in a similar manner,"[2] I have found true in every case where I have examined clays by combined chemical and mechanical methods.

2. *Clay as a Mineral.*—The objections to regarding clay as a mineral may be reduced to two:—1st. That a crystallised or crystalline condition is a necessary character for a mineral species; and 2nd, that the clays are not of definite chemical composition. But, by common assent, such amorphous

[1] Professor Sedgwick (*Camb. Phil. Trans.* I. pp. 104-5) says—speaking of decomposed granite-rock in general—"on a near examination it is frequently found soft enough to be cut with a spade—and it is *in that state* packed up and exported to the potteries." As a matter of fact China-*stone*, which is exported to the potteries in its raw state, is never soft enough to be cut with a spade; while China-*clay*, which may be so cut, is never so exported.

[2] Sorby: *Anniversary Address to Roy. Micros. Soc.* 1877.

Digitized by Google

substances as allophane and gibbsite are admitted to specific rank, while the supposed variations in the chemical composition of clays result from the error of chemists in analysing manifestly impure mixtures instead of China clay,[1] which, freed from foreign bodies, has a composition agreeing very closely with that of Dana's "Kaolinite." The more perfectly an impure clay-mass is cleansed, the more nearly does the resulting material agree in composition and physical characters with that of the best commercial China-clay.

The inclusion of other minerals in natural felspar crystals, and possibly too in some instances the introduction of new substances by the kaolinising solutions, causes the final product of their change to be a mixture of two or more distinct minerals. Completely decomposed felspar, as shown by our former President, Dr. H. C. Sorby, "breaks up into granules of kaolin from $\frac{1}{6000}$th to $\frac{1}{50000}$th of an inch diameter, which have a refractive power so nearly that of Canada balsam that they are best seen when mounted or suspended in water. They are not, strictly speaking, amorphous, nor yet minute crystals, but somewhat flattened and elongated particles very similar to those obtained on reducing undecomposed felspar to a fine powder; as though the original crystalline structure had had a very powerful influence in determining their shape. The depolarising power is very high, and can be easily recognised in particles as small as $\frac{1}{12000}$th of an inch in diameter."[2] So fine are some of the particles, that when suspended in pure water they take five days to subside one foot in depth.[3]

Amongst the granules of decomposed felspar Mr. Sorby found some small needle-shaped crystals, the nature of which he did not determine, but which, if the kaolin he was examining came from Cornwall or Devon, were probably achroite. Besides these, small hexagonal or irregular scales or fibrous looking aggregates of micaceous minerals, as well as minute siliceous grains, are frequent.

At the present time more than a quarter of a million tons of China-clay are annually prepared from decomposed granite in Cornwall and Devon, besides smaller quantities in Germany, France, Spain, the United States, and notably China and Japan. The analyses given in Tables I. and II. will show how little diversity of composition there is throughout the im-

[1] This is true of nearly all the analyses given by Prof. Macadam in No. 33 of the *Min. Mag.* p. 76. and notably of Nos. 1 to 7, 10 to 15, and 20 to 27. Boase's analysis of kaolin, quoted by Mr. Butler at p. 79 of the same No., was evidently made on faulty material, as is shown by the enormous quantity of alkali.

[2] Address to the Royal Microscopical Society, 1877.

[3] *Ibid.* 127.

Digitized by Google

mense series of English China-clays; and the foreign examples examined are quite comparable with these.

TABLE I.

ANALYSES OF COMMERCIALLY DRIED CHINA-CLAY.

	M. * xxx.	Do. No. 2. L. M.	Do. No. 1. L. M. *	R.	B. C. *	L. M.	L. H. B.	Treverbyn A.	Treverbyn B.	Tremayne. No. 1. Yellow.	Do. No. 2. White.
SiO_2	46·60	46·90	41·60	47·84	45·60	45·90	45·83	45·75	45·38	45·40	43·50
Al_2O_3	39·60	38·35	36·60	38·76	39·12	40·40	40·36	40·68	40·11	40·50	40·00
Fe_2O_3	·10	·09	·07	·11	·08	·04	·07	·03	·02	·12	·12
Alkalies .. : ..	·21	1·38	1·56	—	—	—	—	traces	1·17	—	—
MgO	—	—	—	—	—	—	—	0·48	0·36	—	—
CaO	—	—	—	—	—	—	—			—	—
H_2O	13·03	12·55	19·37	12·67	13·51	13·21	12·42	13·01	12·62	13·20	13·40
	99·54	99·27	99·20	99·38	98·31	99·55	98·68	99·95	99·66	99·22	97·02

	M. B.	St. Day.	Carlidden, June 1876, very dry.	Menyridden, June 1876, very dry.	W. B. * 1876.	Rosemellyn.	Rosemellyn.	Treviscoe. * common.	Treviscoe. very common.	Bohemia.	Bohemia.
SiO_2 ..	45·4	45·2	49·1	46·2	46·5	45·89	46·00	49·8	48·14	43·90	48·14
Al_2O_3 ..	40·2	37·8	40·2	41·1	40·2	41·71	39·86	36·9	37·71	38·33	41·48
Fe_2O_3 ..	tr.	1·5	·4	·2	·3	·12	·13	·5	·70	and loss	
Alkalies ..	·6	1·2	—	·5	·6	—	—	·2	—	4·85	·10
MgO ..	tr.	—	·2	·2	·3	tr.	tr.	·4	—	·10	·10
CaO ..	tr.	—	—	—	—	—	—	—	—	—	—
H_2O ..	13·5	12·5	10·3	12·5	13·0	12·80	12·70	12·0	12·20	12·82	10·18
	99·7	98·2	100·2	100·7	100·9	100·52	98·69	99·8	98·75	100·00	100·00

The above were commercially dried clays, mostly of good quality and fairly well washed. The percentage of water varies from 10·18 up to 19·37 per cent., or excluding the third which was distinctly moist, up to 13·51, the average being 12·62. The 26 analyses given by Dana range from 12·47 to 15·90, the average being 14·13. All had been dried by artificial heat in the process of manufacture, and subsequently exposed to the atmosphere. The water was determined in the ordinary way by drying at 100° C, but as I had some reason to suppose that some moisture was still retained, those marked (*) were specially dried and again analysed, with results as in Table II.

Digitized by Google

TABLE II.

ANALYSES OF CHINA-CLAY. (Dried *in vacuo* over Sulphuric Acid.)

	M. B. xxx.	*No.* 1 *L. M.*	*B. C.*	*W. B.* 1876.	*T. Comm.*
Silica ...	48·10	46·10	47·40	47·82	50·60
Alumina ...	41·00	40·60	40·52	41·43	37·60
Ferric Oxide	·10	·09	·09	·30	·49
Alkalies ...	·21	1·62	·10	·39	·20
Magnesia ...	trace	trace	·25	·29	·41
Lime ...	trace	trace	·22	·11	·10
Organic Matter soluble in Alcohol.	·02	·10	·04	·10	·10
Water ...	10·13	10·77	10·61	10·50	10·40
	99·56	99·28	99·23	100·94	99·90

Here the range is very small and the average percentage of water is but 10·5. This may be still too high, although I do not think it is; it cannot possibly be too low.

In the large number of samples of China-clay from different countries which I have analysed and examined during the past 15 years, I have noticed two characteristics:—

1st. An entire absence of scaly or flaky particles when the clay has been adequately washed. These foreign bodies are pretty easily separated, especially in bulk. True kaolin, instead of being "made up largely of pearly scales" (Dana), is in general, and always when properly prepared, absolutely free from them. The hexagonal scales "which may be detected in all [improperly prepared] kaolin," on which Johnson and Blake, followed by Dana, founded their orthorhombic mineral kaolinite, do not appear to have been separated and analysed. They may, indeed, be identical with the Anglesea kaolinite, or they may be lepidolite, gilbertite, nacrite, or sericite, for anything which appears in their paper.[1]

2nd. A great uniformity of composition. This is shown in the foregoing analyses.

Furthermore, it seems well-nigh impossible to make the composition agree with the typical formula adopted by Dana, and after him by most other writers on mineralogy. China-clay properly purified by careful washing, when dried *in vacuo* has invariably a composition very closely agreeing with that given under *a*, Dana's type composition being as under *b*.

[1] See S. W. Johnson and J. M. Blake. *Am. Journ. Science*, 2nd series. Vol. 43, p. 351.

Digitized by Google

			a.	*b.*
Silica	...	...	48·0	46·3
Alumina	...	...	41·2	39·8
Water	...	...	10·8	13·9
			100·0	100·0

The discrepancy here observed may appear small for an amorphous substance; but I think it is of such a nature as both to prove the inaccuracy of Dana's deductions and to point to a more simple formula.

The composition given in *a* answers to the formula $Al_2H_6O_6SiO_2 + Al_2O_3$, $3\,SiO_2$; in other words, one half of the alumina is present as hydrated silicate, the other half as an anhydrous tersilicate. Dana's formula, on the contrary, is $2\,(\frac{1}{4}\,H_2O_3\frac{1}{4}Al_2O_3)\,3\,Si\,O_2$, or Al_2O_3, $2\,SiO_2 + 2\,H_2O$— in other words, all the alumina is in the same state of combination.

Now experiment supports the first formula; for if kaolin be treated with hot sulphuric acid, about half of the alumina is at once dissolved out: the other half remains in combination with the silica, but may be very slowly got out by repeated treatment with the acid.

That Dana's adopted percentages are wrong is shown, I think, by his own table, which gives, out of 26 analyses, no fewer than 6 having the alumina *above* the type proportion as it stands, besides many others where it would be in excess if extraneous matter were eliminated, or if the totals of silica, alumina, and water were calculated up to a total of 100. This would be still more noticeable if the water were to be reduced by about 3 per cent., as it should be according to the indications afforded by Table II. on the preceding page. Making these various corrections the average alumina in Dana's table comes out very close to 41 per cent.

I may here remark that the composition of the Anglesea kaolinite, first determined by Mr. Charles Tookey,[1] if corrected about 4 per cent. for (assumed) retained moisture, as under *c*, agrees with *d*, which is almost identical with the type analysis *a* already given.

			c.	*d.*
Silica	...	...	46·53	48·56
Alumina	...	...	38·93	40·90
Water	...	...	14·94	10·94
			100·40	100·40

If this be accepted as the true composition of the mineral, then the kaolinite of Dana may be looked upon as the crystalline form of kaolin.

That some correction for moisture is necessary is evidenced by the

[1] See *Percy's Metallurgy, Introduction, Refractory Materials, &c.*, 1875, p. 93.

Digitized by Google

pearly lustre of the mineral, generally a sign of hydration. But there is some reason to believe that a larger correction for moisture is necessary, for a sample which I was enabled to examine by the kindness of Dr. Percy, after preservation for many years by him, gave when dried over sulphuric acid *in vacuo* only 8·40 per cent. of water.

3. *The Process of Kaolinisation.*—China-clay rock and China-stone have usually been referred to as "decomposed" or "disintegrated," and many writers have briefly referred to kaolinisation, treating of the occurrence of tin-ores, or of atmospheric effects upon rocks. These writers may be grouped as follows:—

a. Those who speak of "talcose-granite" or "protogine"[1] as the source of kaolin. "Protogine" as defined by these writers, viz. a compound of *quartz, felspar*, and *talc*, is now known to have been founded on a mineralogical mistake. I have as yet never met with a granite containing so much as two *per cent.* of magnesia, which is usually present only in traces, or altogether absent. Certainly there is no such thing as *talc, talcose-granite*, or *protogine*, in the kaolin districts of the West of England, where probably gilbertite has been mistaken for talc.[2]

b. Another class of writers, as Page,[3] for instance, confound the decomposed rock with its later-formed derivatives. As I have elsewhere shown, kaolin is not found in beds and masses along stream-courses, and the richest and purest deposits do not occur in low grounds or farthest from the sources of disintegration. On the contrary, the only kaolin pure enough to be used commercially is obtained from the hills, and *in situ*.

c. Yet other writers attribute the metamorphosis of felspar to carbonic acid gas, acting from above or below.[4] This is probably efficacious as

---

[1] Hawkins. *Trans. Roy. Geol. Soc. Cornwall*, IV. p. 372, &c.
Henwood. *Ibid.* V., pp. 17, 43, &c.
Lyell. *Students' Geology*. 1st edition, 1871, p. 541, &c.

[2] The composition of these two minerals is as follows:—

	Gilbertite, from Stenna Gwynn.	*Talc.*
Silica ...	45·10	62·58.
Alumina ..	36·00	—
Ferrous Oxide	1·10	1·98.
Lime ..	1·50	—
Magnesia ..	·91	35·40
Potash ..	11 40	—
Fluorine ..	·54	—
Water.. ..	3·70	0·04.
	100·24	100.00.

[3] *Economic Geology*, p. 184.

[4] Lyell: *Principles of Geology*, I. p. 413, 1867.

Digitized by Google

[illegible] [illegible] disengage-[illegible] [illegible] but it seems to me that [illegible] districts of [illegible] at least, some [illegible] phenomena indi-[illegible]

[illegible] kaolinisation is produced [illegible] acting from below, [illegible] There is no proof that such [illegible] frequent occurrence in [illegible] and other minerals [illegible] de Beaumont, to [illegible] its presence [illegible] In support of this view Daubrée cites his [illegible] passing vapours of stannic [illegible][1]

Von Buch [illegible] occurrence of kaolin with [illegible] suggested that the kaolin of Halle owed [illegible][2] Daubrée, writing of the kaolin near St. Austell remarks that it must have had a very similar origin.[3]

The decomposed granite of Cornwall and Devon is generally if not invariably accompanied by [illegible] containing fluorine. There is also almost always schorl and very frequently gilbertite, and sometimes topaz or fluor-spar. This latter is scarce, I believe, only because of the absence of lime, as already intimated. Briefly, we may say fluorine is *always* present in some form or other, a fact strongly in favour of Von Buch's theory. Furthermore, it would appear that the action of fluorine and boron on oxide of iron in the presence of silica has resulted in the almost universal presence of schorl, and where lime was present we have now fluor-spar.[4]

4. *Artificial Kaolin.*—Having fully considered kaolinisation from the point of view of Von Buch and Daubrée, I naturally tried experiments

---

[1] *Annales des Mines*, XX. 1841. He used perchloride of tin, as being more readily obtained than the corresponding fluoride; but he argues, and few chemists will dispute it, that similar results would follow from the use of the fluoride. The use of the chloride instead of the fluoride may explain why the artificial oxide differed in form from the natural.

[2] *Min. Tasch.* 1824.

[3] *Ann. des Mines*, 1841.

[4] See, for fuller details, my paper on "Cornish Tinstones and Tin Capels," *Mag.* IV. pp. 123, 124, 1882.

Digitized by Google

on felspar and granite with hydrofluoric acid. I at first employed a leaden tube at a high temperature, through which the vapour acid was passed. As was to be expected, the felspar was rapidly converted into hydrated silicate of alumina, mixed with soluble fluoride of potassium, while pure silica was deposited on the sides of the tube.[1] In later experiments, I have found it preferable to use a dilute solution of hydrofluoric acid at ordinary temperatures. Contrary to what is generally stated, orthoclase seems to be much more readily and completely affected by fluorine than either albite or oligoclase. Labradorite is decomposed only in spots, obsidian also, but very slightly. It is probable that a great many minerals are capable of being thus "kaolinised," and not merely the felspars, The following analyses show what was effected by 96 hours' treatment of orthoclase with hydrofluoric acid at a temperature of 60° F :—

	a.	*b.*	*c.*
Silica	63·70	49·20	44·10
Alumina ...	19·76	35·12	40·25
Potash ...	13·61	·12	·25
Soda	2·26	trace	trace
Ferric Oxide ...	·71	trace	trace
Water	trace	14·20	15·01
	100·04	98·64	99·61

a. is the original felspar analysed by Mr. A. H. Church.

b. is my analysis of the inner layer of the altered felspar, and *c.* that of the outer layer, both dried at 100° C.

The artificial clay so produced, when examined with high powers under the microscope, exactly resembled ordinary well-prepared kaolin. It was entirely free from hexagonal scales, but contained a number of minute colourless cubes, which were probably fluor-spar.

5. *Conclusion.*—It seems to me that this series of experiments and results, taken in conjunction with the facts which I have cited, is quite sufficient to show that the hypothesis of carbonic acid, acting from below, for ordinary kaolin districts, is untenable, particularly as it does not in any way account for the universal presence of minerals of secondary origin containing fluorine, nor for the frequent occurrence of tin-oxide. There is still more reason for rejecting the hypothesis of carbonic acid

[1] Communicated to the Royal Institution of Cornwall some years since

Digitized by Google

[illegible] Whether as a [illegible] of the atmosphere or as a [illegible] produced veins and bands of [illegible] the [illegible] of the country. As regards the [illegible] in situ, I believe that the [illegible] are worthy of general [illegible].

[illegible] to some extent by the sub-[illegible] rock-masses—already [illegible] it is highly probable that the [illegible] a great part in the production of [illegible] surfaces of felspathic and other [illegible] action, frost and other [illegible] particles of such rocks into [illegible].

Note on the Occurrence of what may prove to be a new Mineral Resin.

By J. Stuart Thomson.

[Read October 25th, 1887.]

THIS resin is found in small quantities in the coal from pits at Fauldhouse, Midlothian. It usually occurs in layers not more than $\frac{1}{16}$th inch thick, accompanied by much mineral charcoal, from which it is nearly impossible to separate it perfectly. The colour is dark reddish brown, the streak being somewhat paler. As it does not melt without decomposition, its fusing point cannot be determined. When heated on platinum foil, it froths up, burns with a smoky flame, and leaves a large carbonaceous residue. When burning, the smell recalls that of incense. The resin, when distilled in a closed tube, yields a black thick viscous distillate, with a strong aromatic smell.

It is but slightly soluble in shale spirit and absolute alcohol, readily soluble in benzol, ether, and chloroform, and on evaporation of the solvent it is left as a dark brown brittle substance. Solution in chloroform and subsequent evaporation is, in fact, the best means of separation from the mineral charcoal with which it is so intimately mixed.

The resin, purified by solution in chloroform, gave when distilled with soda-lime indications of the presence of traces of nitrogen. It is also soluble in strong sulphuric acid; from which, on dilution with water, it is precipitated, apparently unaltered, as a slimy mass.

The identification and classification of many of the organic minerals is a matter of such great uncertainty, that I submitted a specimen of the resin to Mr. Fletcher, who reported "that on comparing it with the "resins in the National collection, there is a difference in its appearance. "It most nearly resembles Schraufite, Pyroretinite, and Ajkite. It may "be a constituent of one of the known resins: indeed the resins are "really so 'mixed' that the existence of species may be doubted." From my own examination it most closely resembles Schraufite, and as Schröckinger[1] seems to include several nearly allied resins under this name, it would be premature to consider the Fauldhouse specimen as a new variety, at least until a more thorough examination has been made.

[1] *Verh. Geol. Reichs.* 1875, 134.

Digitized by Google

Obituary Notice of E. H. Furuhjelm.

ON the last day but one of the past year, on the 30th December, 1886, one of Finland's most prominent miners, Enoch Hjalmar Furuhjelm, the Intendant of Mines, was suddenly cut off. Mr. Furuhjelm having been a Member of the Mineralogical Society, the Secretary has requested me to write a short memoir of the deceased for the Journal of the Society, and feeling highly honoured by this request I give the following sketch of Mr. Furuhjelm's public career.

The life of Enoch Hjalmar Furuhjelm exhibits a rich variety of researches and ardent labour in the department of mining industry, which doubtless for him would have opened a future with a more extensive sphere of activity than that in which he has now closed his days, had not his great longing for quiet and warm attachment to his native country made him devote all his abilities to its service.

After completing his preparatory studies at home, he went to Freiberg in the year 1847, and at the famous Academy of that town he increased his stock of knowledge, of which he then had opportunity to make practical use during a journey in the year 1850, when he visited Saxony, Styria, Carinthia, Carniola, The Tyrol, Bavaria, the Hartz and Sweden.

He had scarcely returned to Finland, when he was appointed Mining Engineer and Chemist at the Mines of Count Sergei Stroganoff in the Ural. There he remained till 1853, occupied with divers mineralogical researches in the Ural range, and making geological examinations in the valley of the river Tscheswo, and in the coal formations along the river Kyn in the Perm Government. From 1853 to 1862 Mr. Furuhjelm served the Russian American Company as a mining engineer. About this time he issued several publications, such as a topographical map of the environs of the Fort Novo Archangelsk, on the Island of Sitka, a geological survey of the so-called Indian Archipelago between Sitka and the North American Continent, and a geological examination of the Unalaschka Islands belonging to the Aleutian group. In the year 1856 he founded a settlement at Cook's Passage at the English Bay, and from 1859-62 he was the inspector of this settlement. During his engagement in the service of the above-mentioned Company he made extensive journeys, and visited the copper works in Chili and California as well as the gold washings

Digitized by Google

on the Western slope of the Sierra Nevada. When he resolved to give up his situation in the service of the Company and to return to Finland, he made a tour on his return journey through the United States of North America, South Wales and Belgium.

From 1865-67 Mr. Furuhjelm was the Director of the Geological Survey of Finland, just then commenced. Later he undertook an official journey to Acoz in Belgium, where he stayed two years.

The geologic-paleontological material collected by Mr. Furuhjelm at Sitka has been described by Heer in his *Flora Fossilis Alaskana*, which publication also contains Mr. Furuhjelm's description of the geological formations of Sitka. In 1874 Mr. Furuhjelm was elected a member of the Geological Association of Stockholm, in 1875 a member of the Iron and Steel Institute in London and of the Imperial Russian Mineralogical Society in St. Petersburg. In 1880 he became a member of the Mineralogical Society of Great Britain and Ireland. In 1882 he was appointed Vice-President of the Jury for Group IV. of the Universal Russian Exhibition in Moscow.

Such was in short the public life of this energetic and laborious man. A man in the finest significance of the word, endowed with a noble and feeling heart, hidden behind an exterior somewhat harsh and rough, from his early life having been so full of hardship and struggle.

May he rest softly and peacefully in the grave, which so unexpectedly closed over him!

HJALMAR GYLLING.

Helsingfors, October 1887.

Digitized by Google

Abstracts.

Ueber die Natur der Glasbasis sowie der Krystallisationsvorgänge im eruptiven Magma. Von Dr. A. Lagorio. *Tscherm. Min. Mitth.* Band VIII. p. 421.

This communication represents many years of work. It covers over a hundred pages, and contains a hundred and two original analyses. The main body of the work is divided into two parts. The first contains a statement of the observed facts; the second is taken up with a discussion of the results. In the introduction the author describes the methods of observation, and makes a few general remarks which indicate his point of view. A magma may become crystalline either by the *simultaneous* development of several different molecular groups (minerals), or by the *successive* crystallisation of different compounds. In the latter case *one and the same compound is never formed at two different* periods. Minerals belonging to the same group (*e.g.* felspars) may be formed at two different periods, but when this is the case they have not the same composition. The author considers that the laws which regulate the separation of minerals in igneous magmas have been to a great extent obscured by the common practice of considering simply the molecular relations of the silica, sesqui, and mon-oxides; thus lumping together the alkalies and alkaline earths. K_2O and Na_2O behave very differently in the formation of crystalline compounds, and have very different affinities for CaO and MgO. Rosenbusch has stated that minerals separate according to a law of increasing acidity. This empirical law is not supported by any established chemical principles, and is moreover contradicted by many facts. It appears that the separation of minerals is governed by a number of subtle chemical and physical conditions. From the fact that many rock-forming minerals may be formed both in the wet and dry ways, the author draws the conclusion that the affinities of the chemical constituents are to a great extent the same in aqueous solutions as in molten magmas, and that the general laws established with reference to crystallisation from aqueous solutions are applicable to crystallisation from igneous magmas.

The first part of the record of experimental work deals with rocks containing a high per-centage of silica, and especially with the spherulitic

Digitized by Google

liparites and rhyolites. Twenty-eight analyses are given. These analyses show (1) that the spherulitic bodies are somewhat richer in silica than the containing glass, (2) that they contain (relatively to potash) more soda than the glass. It follows, therefore, that in a magma containing much silica and alkali, and comparatively little lime and magnesia, the soda compounds have a greater tendency to separate out in crystalline form than the potash compounds. Moreover, seeing that the soda-silicate contains a higher silica percentage than the potash-silicate, it follows that the more "basic" potash-silicates succeed the more "acid"[1] soda-silicate. As regards the formation of felspars the analyses point to the conclusion that when the ratio of $K_2O : Na_2O$ is above a certain quantity—about 2 : 1—a sanidine more or less rich in soda is formed; when it is below this point a triclinic soda-felspar is formed.

It will be observed that the results of Lagorio show that the common opinion that the spherulites possess the same chemical composition as the containing glass requires modification. Considering the number of his analyses, the care with which they have been executed, especially as regards the alkalies, and the wide area from which the rocks were collected (Lipari, Teneriffe, Hungary, the Crimea, and America), it is impossible to set aside his results as exceptional. We quote five of the twenty-eight analyses.

	I.	II.	III.	IV.	V.
SiO_2 ...	72·35	73·21	73·05	74·52	73·42
Al_2O_3 ...	13·97	12·90	14·67	12·97	14·29
Fe_2O_3 ...	1·29	2·10	0·89	2·02	1·01
CaO ...	0·72	0·88	0·97	0·92	1·00
MgO ...	0·46	0·27	0·26	0·25	0·43
K_2O ...	5·38	4·75	5·11	4·53	3·19
Na_2O ...	3·58	4·83	3·99	4·26	5·61
Loss ...	1·37	1·04	0·91	0·83	0·84
	99·12	99·98	99·85	100·30	99·79
Sp. Gr.	2·132	2·112	2·21	2·089	2·523

I. Spherulitic obsidian. Lipari. Glass.
II. Spherulite from the above.
III. Spherulitic obsidian from Teneriffe.
IV. Spherulite from the above; outer part.
V. Ditto ditto inner part.

[1] In Rosenbusch's sense; not in the true chemical sense.

Digitized by Google

The author next deals with the rocks containing a medium percentage of SiO_2—the andesites and trachytes. Analyses of the rocks, of the bases, and of the felspars are given—26 in all; from these we select the following at random :—

	I. (Rock.)	II. (Groundmass.)	III. (Felsp.)	IV. (Rock.)	V. (Base.)	VI. (Felsp.)
SiO_2 ...	65·32	74·76	56·53	67 30	72·44	62·21
Al_2O_3 }	19·61	13·66	26·59	20·75	16·28	19·29
Fe_2O_3 }		2·36	1·05			1·08
CaO ...	4·24	2·17	9·60	2·63	0·59	1·18
MgO ...	1·35	0·53	—	1·05	0·20	0·05
K_2O ...	1·45	2·05	0·80	4·60	6·49	12·00
Na_2O ...	4·06	2·96	6·11	2·75	2·12	2·54
Loss ...	0·54	0·82	0·02	0·34	1·35	1·05
	100·17	99·31	100·70	99·42	99·47	99·40
Sp. Gr.	2·765	2·618	2·685	2·541	2·254	2·567

	VII. (Rock.)	VIII. (Base.)	IX. (Felsp.)	X. (Rock.)	XI. (Base.)	XII. (Felsp.)
SiO_2 ...	62·54	70·19	55·42	57·76	65 05	53·95
Al_2O_3 }	23·56	17·19	28·01	18·39	17·60	27·45
Fe_2O_3 }			1·09	7·51	3·10	1·09
CaO ...	4·75	2·50	9·12	6·21	3·58	11·48
MgO ...	1·15	0·53	tr.	3·34	1·05	tr.
K_2O ...	2·43	3·89	0·79	2·61	4·16	0·79
Na_2O ...	3·16	3·30	5·10	3·63	3·54	4·51
Loss ...	1·75	2·31	0·52	0·94	1·56	0·48
	99·34	99·91	100·05	100·39	99·64	99·75
Sp. Gr.	2·694	2·414	2·689	2·664	2·375	2·690

I. Dacite from Mojanda, Quito.

II. Groundmass of I.

III. Felspar from I. This felspar lies between $Ab_4\ An_3$ and $Ab_1\ An_1$. Extinction on M, −12°; on P, −3°.

IV. Trachyte from Mte. Amiata, Tuscany.

V. Glassy base of IV.

VI. Felspar from IV., Sanidine.

VII. Andesite (trachytic type) from Hliniker Thal, Hungary.

VIII. Glassy base of VII.

IX. Felspar from VII. Answers to $Ab_1\ An_1$ Labradorite.

Digitized by Google

X. Vitro-andesite, ejected block from Menapi, Java, Dec. 1876.

XI. Base of X.

XII. Felspar from X; answers to $Ab_1 An_2$.

In discussing the analyses the author points out that there must be a relation between the composition of the magma and the crystals which separate out of it. Seeing, however, that the minerals form successively, it by no means follows that this relation is exhibited by comparing the analysis of the porphyritic crystals with the bulk analysis of the rock. The porphyritic felspars, for example, form after the ferro-magnesian constituents, augite, &c. Hence the magma out of which the felspars separate is not represented by the whole rock, but by this minus the earlier formed crystals. By combining analyses V. and VI., and taking into consideration the relative amounts of sanidine and groundmass, he ascertains that the magma out of which the sanidine separated must have possessed the following composition:—SiO_2 69·88, $Al_2O_3 + Fe_2O_3$ 17·30, CaO 0·71, K_2O 7·78, Na_2O 2·22. This gives 1 : 2·3 as the ratio of $Na_2O : K_2O$. Inasmuch as the pyroxenes are among the earliest minerals to form, it follows that there is a direct relation between their composition and that of the rock, a fact established by the researches of Mann, Merian and Doelter.

The author's results confirm the generally accepted view as to the effect of crystallisation in andesitic magmas; the magma remaining after a certain amount of crystallisation is richer in silica, poorer in lime, iron and magnesia, and richer in potash relatively to soda.

Rocks containing a medinm percentage of silica and a high percentage of alkalies are next considered, and then those which contain a low percentage of silica. The latter are treated of in two sections, according as they possess a low or high percentage of alkalies.

	I. (Rock.)	II. (Glass.)	III. (Rock.)	IV. (Glass.)
SiO_2	52·87	52·68	40·48	40·64
Al_2O_3	16·36	18·28	8·93	34·78
Fe_2O_3	10·87	9·43	20·05	
CaO	7·94	8·04	13·03	7·25
MgO	5·23	4·68	11·12	5·15
K_2O	0·96	1·15	1·26	3·50
Na_2O	3·64	3·86	2·05	3·04
H_2O	1·22	1·02	3·37	5·17
	99·09	99·14	100·29	99·53
Sp. Gr. ...	2·793	2·773	2·931	

Digitized by Google

I. Vitro-basalt from Schwarzenfels, Rhön.

II. Glassy base of I.

III. Limburgite from the Kaiserstuhl.

IV. Glassy base of III.

The tendency of sodium-silicates to separate out in preference to potassium-silicates is illustrated by the fact that where nepheline occurs it precedes the felspars. In all magmas iron, lime, and magnesia have a strong tendency to separate out. Where lime is present alone, or associated with only small amounts of magnesia and potash, it may reach a high percentage without the magma becoming saturated. The portion of the paper which deals with experimental work concludes with an account of experiments on the fusion of various rocks and minerals with the chlorides and (in one case) sulphates of the alkalies. These experiments show that both acid and basic rocks will take up a considerable quantity of the alkalies under these circumstances, but that there appears to be a definite limit to the amount which they will so take up. Under the same conditions sodium is taken up in slightly greater quantity than potassium. The experiments with minerals, epidote, albite, adularia, and leuchtenbergite, were made for the purpose of illustrating the relation between the alkalies and alkaline earths. The principal results may be summarised as follows :—

(1.) Epidote fused with the mixed chlorides or sulphates of sodium and potassium in atomic proportions takes up sodium much more readily than potassium.

(2.) A mixture of albite and adularia fused with calcium chloride gives rise to a product in which the alkalies are to a very large extent replaced by lime. Sodium, however, is less completely replaced than potassium. In original mixture Na : K = 1 : 1 ; in fused product Na : K = 2 : 1.

(3.) Leuchtenbergite fused with a mixture of KCl and NaCl in atomic proportions takes up potassium more freely than sodium, but takes up neither so readily as epidote.

All these points are in accord with the known composition of rock-forming minerals. Calcium-silicates frequently contain alkalies ; magnesium-silicates containing alkalies are rare. K_2O is the alkali usually found in magnesium-silicates ; Na_2O, on the contrary, is the common alkali in calcium-silicates.

The alkalies form, by preference, acid compounds ; the alkaline earths and iron-oxides form basic compounds.

In the cooling of silicate magmas compounds of CaO, MgO, and FeO first crystallise out ; then follow Na compounds, and finally K or K Na

Digitized by Google

compounds. If K is present in great excess its compounds may crystallise out before those of Na, but there still remains a magma relatively rich in K.

The third part of the paper is more or less theoretical. It may be described as an attempt to bring into relation the facts known with regard to artificial glasses, igneous rocks and saline solutions. Silicate-magmas are regarded as solutions, and the laws established with reference to the separation of salts from saturated and super-saturated solutions are applied to explain the phenomena of igneous rocks. In the first place, the researches of Dumas,[1] Benrath,[2] Pelouze,[3] and others on the character and composition of artificial glasses are referred to. The results of these researches may be thus summarised. Molten silicate solutions become less readily saturated with silicates of alumina and potash than with silicates of soda. CaO, MgO and the oxides of the heavy metals readily saturate silicate solutions, and therefore readily separate out, partly as oxides (*e.g.* Fe_2O_3). The fact that potash-glass is less subject to devitrification than any other is correlated with the fact that the basis of eruptive rocks is always richer in potash than the rock taken as a whole.

As regards the formation of spherulites in the acid rocks, the author insists on the fact that these bodies are proved by his analyses to be always richer in silica and soda than the matrix. In the preparation of glasses sand is mixed with carbonates and sulphates so that CO_2 and SO_3 are liberated in the fusion. The formation of spherulites is frequently determined by the non-escape of gas bubbles or by the presence of unfused portions of the original material. Spherulites in igneous rocks are, he considers, especially abundant where gases and vapours have passed through the magma.

Rock-magmas are more or less saturated solutions of various silicates. The most probable assumption is that the silicates are present in the solution as definite compounds, that is, as definite molecular groups. The evidence of this is that the rock-forming minerals constitute a small group, and the same minerals separate out of various acid and basic magmas. Seeing that minerals of the same species may vary considerably in composition, owing to isomorphous replacements, the definite compounds present in solution are the fundamental compounds which go to build up the different minerals. The author then gives an

[1] *Chim. app. aux Arts.* Article "Verre."

[2] *Beiträge zur Chem. d. Glases.* Dorpat, 1871, 41.

[3] *Compt. Rend.* 1857, 47, 693.

Digitized by Google

account of the principal facts which have been established with reference to saline solutions. One or two of the most important of these may be here referred to. Soret has shown that if different portions of a solution be at different temperatures the salt will tend to accumulate in the colder portions.[1] In the cooling of saline solutions the excess of the salt first crystallises, and then the cryohydrate—a mixture of salt and water.[2]

A liquid may be cooled below its fusing point without solidification. When it solidifies the temperature is raised to the fusing point. The same is true for super-saturated solutions; the temperature becomes raised when crystallisation takes place. The view of Bunsen, that there is no essential difference between fusion and solution, has been confirmed by subsequent observers.

Accepting this view, what then must be regarded as the solvent medium in natural silicate-solutions? The author's analyses point to the conclusion that this is a silicate of the composition $R_2O.2SiO_2$, where R = K; with which, however, Na is in all probability associated. The silicates $RO.2\ SiO_2$ and $\dot{R}_2O_3.6\ SiO_2$, where R = Ca and $\dot{R}$ = Al, also play a similar rôle, but never alone; always in combination with the first. The first mentioned silicate, which the author terms "normal glass," will dissolve SiO_2, bases and silicates, until it becomes saturated. By rapid cooling the solution may be made to consolidate as a glass. MgO and oxide of iron show, however, a strong tendency to separate out of it. Normal glass will dissolve much alumina without prejudice to its amorphous condition, but it is very sensitive to oxides of the heavy metals and magnesia; to the latter especially when alumina is present, as is shown by the formation of spinel. SiO_2 behaves similarly. By considering these relations of the solvent medium we can explain why certain minerals, such as quartz and leucite, mutually avoid each other; and why certain others, such as quartz and olivine, occur together. Sorby has shown that the solubility of salts, which increase in volume as they pass into solution, is lowered by pressure; in other words, pressure tends to make them separate out. This is the case with the rock-forming silicates. The solvent medium (glass), on the other hand, will follow Thomson's law, and have its fusing point raised by pressure. Hence

[1] *Ann. Chim. Phys.* 1881 (5), 22, p. 293. The principle here referred to, if of general application, must be of the very first importance. It shows how a differentiation may arise in a homogeneous mass of molten material, and may serve to explain many phenomena of plutonic rocks.

[2] Guthrie. *Phil. Mag.* 1875 (4), 49. *Ibid.* 1876 (5), 1 p. 49.

Digitized by Google

porphyritic crystals formed under pressure may be partially dissolved and corroded when the pressure is diminished. The author does not consider that the corrosion of porphyritic crystals, so commonly seen in eruptive rocks, is due, as Rosenbusch supposes, to the "acidifying" of the magma. It may, however, be due in certain cases to a change in the composition of the magma, or even to the temporary elevation of the temperature of a mass of cooling material consequent upon rapid crystallisation after supersaturation has been reached. The principle of Soret furnishes a plausible explanation of the occurrence of glassy matter in the centre of a dyke. If the molten mass remains stationary for any length of time liquation will take place, and the basic compounds will concentrate in the marginal portions, leaving the central portions richer in the "normal glass."[1]

If a silicate-solution composed of different compounds be cooled below the fusing point of these compounds—in other words, if it become supersaturated—then it may consolidate rapidly throughout its entire mass, and produce a rock of granitic structure. Slow crystallisation is not likely to develope the granitic structure, which is characterised by the fact that the different minerals mutually interfere with each other. The conclusion is reached, therefore, that the granitic structure implies rapid crystallisation. This does not exclude slow cooling; indeed, it requires it, for without slow cooling the necessary over-cooling or supersaturation could not be attained.

Supersaturation depends on temperature. Gradual diminution of temperature causes a magma to become successively supersaturated with different compounds. Solutions strongly supersaturated with a certain salt readily yield large crystals of that salt. Decrease of pressure or increase of temperature in a magma in which crystals are present will cause a portion of these crystals to be dissolved. When cooling again takes place a second generation of crystals will be formed. The composition of the constituents of the second generation will depend upon the composition of the magma; their general mineralogical character will, on the other hand, depend upon that of the first formed crystals with which they are isomorphous. Since the size of the crystals depends on the amount of supersaturation, those of the second generation will be smaller than those of the first, because the presence of crystals in a solution pre-

[1] This explanation may apply to the Eskdale Dyke described by Dr. Geikie, Roy. Phy. Soc. Edin., Vol. V. 1880, p. 219. The analyses of the vitreous and crystalline portions of this dyke are exactly such as they should be, according to theory. J. J. H. T.

Digitized by Google

[illegible] a high degree of supersaturation as regards the compounds which form the crystals of the microliths with these. The experimental part of the work has established the fact that the following compounds will saturate silicate-solutions in the order in which they are mentioned: K-compounds and SiO_2, Na-compounds, Ca- Mg- Fe-compounds and the rocks. In other words, those first mentioned are the most soluble, those last mentioned the most insoluble. If we consider the above compounds in relation to supersaturation their order will be reversed, for the more soluble salts always furnish supersaturated solutions more readily than those which are less soluble.

Large well-developed crystals are rapidly formed from supersaturated solutions. The porphyritic crystals of igneous rocks accord with the view that they have been formed under these conditions. Orthoclase, sanidine, and leucite occur in the largest crystals; then follow quartz and the lime-soda felspars, and last come the normal silicates (augite, hornblende). The more insoluble salts can only form large crystals by slow crystallisation. If we assume a solvent medium, we find a natural explanation of the phenomena of crystallisation in igneous rocks by supposing that the crystallisation is determined by the following factors:—the influence of the mass of the dissolved compound, the affinities of the bases for each other, and the readiness with which the different compounds will furnish supersaturated solutions.

The general order of separation of compounds is as follows:—Oxides, Fe-silicates, Mg-silicates, Fe—Mg—, Mg—Ca—, Mg+K— (or Fe+K—), Ca—, Ca—Na—, Na—, and lastly, K-silicates, SiO_2. SiO_2, however, may be formed before K-silicates, generally it appears simultaneously with the alkali-felspar. The glassy base in the acid and basic rocks possesses almost the same percentage of silica as the rock in which it occurs; in the intermediate rocks it is more acid than the rock itself. In the very acid rocks it is more basic, in the very basic rocks more acid than the rock taken as a whole.

The author points out that there appears to be a connection between the order of separation and the specific heat of minerals. Experiments on the specific heat of rock-forming minerals have, however, been too few to warrant any confident generalisation.

He concludes by offering some criticisms on the recent classification of rocks proposed by Rosenbusch, and states that the giving up of geological age as a principal factor in rock-classification is to him a joyful innovation (*eine erfreuliche Neuerung*), a sentiment which British petrographers will cordially reciprocate. J. J. H. T.

Digitized by Google

Beiträge zur Kenntniss der Nosean-führenden Auswürflinge des Laacher Sees. Von Lucius L. Hubbard. *Tscher. Min. Mitth.* Band VIII. Heft 5.

The ejected blocks of the volcanic district of the Laacher See comprise:—

(1) Crystalline schists.

(2) Sanidinite, consisting entirely or principally of sanidine.

(3) The so-called Laacher trachyte of von Dechen.

(4) Basalt-bombs.

The blocks of sanidinite and Laacher-trachyte occur of all sizes up to masses measuring two feet in diameter. They may be round, oval, or angular. The sanidinite consists principally of sanidine, or of sanidine and nosean. The accessory constituents are plagioclase, magnetite, mica, titanite, zircon, nepheline, scapolite, melanite, orthite, and other rare minerals. The rock may be solid throughout or cavernous. The cavities contain fine crystals of magnetite, titanite, nosean, hornblende, mica, orthite, apatite, &c.

The Laacher-trachyte is light or dark grey, often almost black. It is usually porous. In chemical composition it stands between sanidinite and basalt. It contains crystals of sanidine, plagioclase, augite, mica, olivine, titanite, magnetite, hornblende, and zircon, in a lava-like groundmass. A special variety of rock which must be classed with the sanidinites shows a gneissose or banded structure. After referring to the theories that have been proposed to account for these peculiar ejected blocks, the author proceeds to consider the characters of the more important and interesting minerals which occur in the sanidinite and Laacher-trachyte.

Hauyne (*Nosean*).—The author remarks on the difficulty of distinguishing hauyne from nosean in the absence of the blue colour which often characterises the former. In his descriptions he applies the term nosean to all those minerals of the hauyne-nosean group which are not blue. In this sense nosean is one of the most characteristic minerals of the sanidinites and trachytes. It is well crystallised in the druses, and generally occurs in the form {110} or in the combination {110} and {100}. Hauyne is much less common. Granular nosean is often met with associated with sanidine and other minerals, or occurring by itself in vein-like masses. Both hauyne and nosean show a characteristic greasy lustre.

The colour is variable, not only in different individuals but in different portions of the same individual. Very often the kernel is dark and the

Digitized by Google

border light, or *vice versâ*. Under the microscope the nosean often shows a cloudy appearance, due to extremely minute gas inclusions. These inclusions may be distributed through the section without order, or they may be arranged in straight lines corresponding to the traces of faces of the tesseral system, thus producing a zonal structure. The external zone of an individual is usually remarkably free from inclusions of all kinds, in which respect the noseans of the ejected blocks differ from those of the leucitophyres of Rieden and Olbrück. In addition to the minute gas inclusions above referred to and a few liquid cavities, there occur also small opaque rods and plates which the author regards as magnetite. In the fresh condition these show a metallic lustre; when altered, as is frequently the case, they are yellow or red and without the metallic lustre. The rods have a breadth of about ·0025 mm., the plates measure about ·03 mm. across. Where both rods and plates occur together the former are about as long as the latter are broad. This points to the conclusion that the rods are merely cross-sections of the plates.

The nosean frequently shows traces of having been affected by heat subsequent to its formation, and has often been partially melted. In one case it was represented by a clear green glass in which perlitic cracks were observed.

Orthoclase, Sanidine.—Sanidine occurs in tables with conspicuous development of the clinopinacoid {010}, and also as rectangular prisms showing the forms {001} and {010}. Carlsbad twins are not uncommon, and in one case the face of composition was (100). Doelter and Hussak have shown that felspars may be rendered granular by the action of molten magmas. The sanidine of the ejected blocks sometimes shows a similar granulation. In some cases the original crystals have been broken up, and the parts more or less separated from each other. When this is the case the rocks contain more or less groundmass, which sometimes consists of a clear glass in which new felspar has been generated. A variety of Laacher-trachyte was found to consist of sanidine and a dark grey substance having the aspect of lava. The sanidine in this rock has been both corroded and broken, whereas the other minerals, augite, titanite, and magnetite, have been but little modified. These facts indicate that the rock, as now seen, is the result of the action of a lava-magma upon an original mass of sanidinite. In this rock and in the normal Laacher-trachyte the original sanidinite is fringed with what may be termed secondary sanidine. Small microlites of the secondary sanidine occurring singly or grouped in bundles or spherulites, may also be observed in a

Digitized by Google

glassy groundmass containing large broken and rounded crystals of the original sanidine.

In the nosean-sanidine rocks the sanidine occurs not only in more or less broken and rounded crystals, but also in aggregates which, in a certain sense, remind one of spherulites. The individuals of these aggregates group themselves in a more or less radial manner. They are distinct from the larger rounded or broken crystals, and must be regarded as of later date. Their composition is as follows :—

SiO_2	65·865
Al_2O_3	21·190
Fe_2O_3	0·446
CaO	0·568
MgO	tr.
Na_2O	6·766
K_2O	5·724
	100·054

The nosean is, as a rule, younger than the original sanidine, but it may be either younger or older than the secondary sanidine. The author divides the nosean-bearing rocks which occur as ejected blocks into four groups :—

(1) The so-called Laacher-trachyte and transitional forms.

(2) Rocks consisting of older sanidine, and which may contain also a granulated sanidine or orthoclase.

(3) Rocks characterised by the presence of nosean and radial aggregates of secondary sanidine in considerable quantity. These may also contain older sanidine.

For rocks of the third type the author proposes the term noseanite.

Plagioclase. - This mineral occurs frequently, but is rarely found in well-formed crystals. Many blocks consist almost entirely of plagioclase but the mineral is present only in very subordinate quantity in the noseanite. It occurs generally in forms giving lath-shaped sections or else in small grains, and is often intergrown with orthoclase.

Olivine.—This mineral has not been recognised in the microscopic sections of the nosean-bearing blocks, but it has occasionally been detected by microscopic examination.

Titanite.—This mineral occurs abundantly as well-formed crystals, and as rounded or angular grains, both in the sanidinite and Laacher-trachyte.

Digitized by Google

soda-orthoclase or anorthoclase. The occurrence of normal orthoclase in the Brazilian rocks to the almost entire exclusion of the other varieties is a feature of interest. The composition of the mineral is represented by the following analysis made in the laboratory of Fresenius :—

SiO_2	...	63·52 per cent.
Al_2O_3	...	19·21 ,,
Fe_2O_3	...	0·56 ,,
MgO	...	0·10 ,,
CaO	...	0·63 ,,
Na_2O	...	3·08 ,,
K_2O	...	12·89 ,,
		99·99 per cent.

The single exception to the rule that the felspar is normal orthoclase occurs in a specimen which shows the contact of a phonolitic dyke with the granular elæolite-syenite. The felspar in the syenite here shows a very fine striation, which is especially noticeable under crossed nicols. This striation is probably indicative of a fine micro-perthitic intergrowth of two felspars.

The elæolite is almost as abundant as the orthoclase. It possesses a Sp. Gr. of 2·592, and sometimes occurs in idiomorphic crystals which only show a slight rounding of the edges and angles. It contains fluid inclusions which often constitute negative crystals. Cancrinite, analcime, arise by alteration of the nepheline.

Definitely recognisable sodalite is not very abundant. Well-formed crystals may be sometimes seen enclosed in the felspar.

Analcime occurs as a secondary constituent after both nepheline and sodalite. The author recommends the following as a means of distinguishing between sodalite and analcime. Uncover the slide and remove the canada balsam. Place a drop of very dilute nitric acid (free from chlorine) or acetic acid on the mineral to be tested, and allow it to act for a short time, say a few seconds; then add a drop of a dilute solution of lead nitrate or lead acetate and place the section under the microscope. If sodalite be present long flat needles of lead chloride will be seen to form.

The hornblende is only seen to be transparent in brown or greenish-brown colours when the sections are very thin. It is idiomorphic in the prismatic zone, and often twinned according to the ordinary law. The extinction as observed in cleavage flakes is 13°-16°. Pleochroism and absorption are strong: γ (nearly) $= \beta > \alpha$; γ, greenish brown; β, dark

Digitized by Google

brown; a, light greenish brown. Alumina, magnesia, and alkalies were detected by micro-chemical tests.

Pyroxene is present only in very small quantity in rocks of the present group, and is often absent altogether. It is without definite form. Sections at right angles to the vertical axis are greenish yellow when viewed with rays vibrating parallel to the optic axial plane, and a peculiar reddish grey when viewed with rays vibrating at right angles to this plane. The mineral gives a higher extinction in the prismatic zone than ægirite, and possesses a very strong dispersion $\rho > \nu$.

The dominant mica is dark brown and strongly pleochroic, with a very small optic axial angle. It never occurs in well-formed crystals. A second variety, having a sap-green or olive-green colour, sometimes occurs. It often shows well-defined six-sided outlines. Titanite is present, and occurs both in well-formed crystals and as grains.

The dominant type of rock is formed principally of orthoclase and elæolite, and the former is generally somewhat in excess of the latter. These two constituents determine the general aspect of the rock as regards colour and size of grain, the other constituents being completely subordinate to them. The structure of the rock is granitic; its specific gravity is 2·566. As already stated, hornblende is the dominant ferro-magnesian constituent. This is an interesting point, because hornblende is turning out to be a somewhat rarer mineral in the elæolite-syenites than was formerly supposed. The constituents of the rocks often show the effects of mechanical deformation and chemical corrosion. As an illustration of the latter, the opacite-border, which almost always surrounds the hornblende, may be especially mentioned.

Small veins, at most only 2 mm. broad, often traverse the rock above described. These are poorer in the ferro-magnesian constituents, and richer in felspar, elæolite, and accessory minerals, such as garnet, fluorite, orthite (?) and laavenite, than the main mass of the rock. The grain of the rock forming these veins is less coarse than that of the rock, and the felspars are markedly lath-shaped.

The rock with striated felspar must be regarded as a special type of the first group. It differs from the normal type not only in the character of its felspar, but also in the fact that augite is as abundant as hornblende. Mica is present in considerable quantity, and is usually much decomposed. Cancrinite has been developed at the expense of elæolite. It occurs as long irregularly bounded rods, which are always similarly orientated in the same individual. Titanite occurs only in the form of colourless grains, and is associated with ilmenite and calcite. The ilmenite shows some-

Digitized by Google

times very sharp boundaries. Tourmaline and cassiterite occur as accessory minerals in the rock now under consideration.

We pass now to the second group of rocks. These are similar to the former in structure, but they contain ægirite instead of hornblende. Fluorite is fairly abundant, and also two of the rarer minerals—laavenite and rinkite. The ordinary minerals are similar to those already described. The ægirite is green by transmitted light, strongly pleochroic and idiomorphic in the prismatic zone. The laavenite occurs as small honey-yellow crystalline grains, and appears to be regularly distributed throughout the rock. In examining hand specimens it is scarcely recognisable, and may be easily confused with titanite. It is characterised by strong refractive and double-refractive power; thus it gives the white of the higher orders even in thin sections. It sinks in a solution having the specific gravity 3·526. It dissolves in fused acid potassium sulphate, and the solution in water gives with H_2O_2 the reaction for titanium. Sodium (abundant), calcium, magnesium, manganese and iron were proved by micro-chemical tests. The mineral is monoclinic, with a cleavage parallel to the orthopinacoid. The optic axial plane lies parallel with the clino-pinacoid, and $a = \gamma$, $b = \beta$ and $c = \alpha$. The mineral is strongly pleochroic; β, dark yellow; α, light yellow or colourless.

The crystallographic characters were determined by goniometric measurements on some fairly well-formed crystals which were found amongst the grains isolated by means of heavy solutions.

The second accessory mineral is somewhat more abundant than laavenite. The most common sections are bounded by two sides which lie parallel to the direction of elongation. There is a perfect cleavage parallel to the direction of elongation. The refractive power is high, but the double-refraction is low, the common tints in thin sections corresponding to the yellow-orange of the first order. The extinction is either parallel to the cleavage or deviates from it only by a few degrees. The major axis of depolarisation lies parallel with the cleavage. The plane of the optic axes lies at right angles to the cleavage, or nearly so. The mineral is pleochroic; colourless for rays vibrating parallel to the cleavage, and light yellow for rays vibrating at right angles to the cleavage. The sections described above are attacked by concentrated HCl with separation of gelatinous silica. The mineral is frequently associated with laavenite and fluorite. The author has compared this mineral with the rinkite of Steenstrup and Lorenzen, and believes it to be the same.

Digitized by Google

The geological relations of the ægirite-bearing rocks are not known as the specimens examined were all from boulders in the Rio de Curo.

The rocks of the third group occur as dykes, and are characterised by their porphyritic structure. A typical specimen consists of a compact green groundmass containing white porphyritic constituents. The groundmass is a fine-grained granular aggregate of orthoclase, elæolite, and ægirite. Its specific gravity is 2·628; that of the entire rock is 2·616. The porphyritic constituents are orthoclase in somewhat tabular crystals, elæolite in well-formed crystals, and having all the characters of nepheline, sodalite, and more rarely augite. Magnetite and titanite are also mentioned in this connection. Besides the above minerals the groundmass encloses polygonal patches of elæolite-syenite precisely similar to the rock in which the dyke occurs. These patches are fairly uniform in size, and somewhat less than an inch across. The sections of these patches are bounded by straight lines which meet in sharp angles, so that at the first glance one is strongly inclined to regard the patches as porphyritic crystals. Apart from their peculiar external form they have the structure and composition of the neighbouring elæolite-syenite.

The author differentiates these rocks from the true phonolites which they so closely resemble by the character of their groundmass. This, he says, possesses the hypidiomorphic granular structure of plutonic rocks, and not the panidiomorphic granular structures of the normal phonolites.

The petrographical work was done in the laboratory of Prof. Rosenbusch.

J. J. H. T.

Andalusit-führende Granite. Von E. Cohen. *Neues Jahrbuch*, Band II. 1887, p. 178.

The author describes the occurrence of a mineral resembling andalusite in certain granites from the Vosges and the Black Forest. The same mineral is abundant in a tourmaline-granite from Alt-Zschillen, near Wechselburg in Saxony. It occurs as long or short columns, which always lie isolated from each other, never grouped as in contact-rocks and crystalline-schists. The terminations are most frequently irregular, fringed or ruin-like. A roof-like ending, however, not unfrequently occurs. The longitudinal sections give strraight extinction. Cross sections show that the prism is nearly rectangular, and that extinction takes place parallel with the diagonals. The greatest axis of elasticity always lies parallel with the length of the crystal $c = a$. All crystals show pleochroism. Rays vibrating parallel to c are light or dark red, the intensity varying considerably in one and the same individual. Rays vibrating parallel to

Digitized by Google

a and *b* are colourless, or nearly so. Specific gravity lies between 3·05 and 3·15. The above facts prove the mineral to be andalusite. It thus appears that Professor Cohen and the present writer[1] have simultaneously recorded the occurrence of andalusite as an original constituent of certain granites. J. J. H. T.

Origin of the Ferruginous Schists and Iron-ores of the Lake Superior Region. By R. D. Irving. *American Jour. Sci.* Vol. XXXII. October 1886.

The iron-ores of this region (magnetite and hematite) occur in association with jaspery and cherty rocks. There has been considerable difference of opinion amongst previous writers as to the origin of these ores and their associated rocks; some referring them to a sedimentary, others to an eruptive origin. The geological surveyors in the course of their investigations have recognised the existence of carbonate-bearing beds in the iron-bearing regions, and have been led to regard the jaspery and cherty schists and the iron-ores as the result of the alteration and silification of beds of carbonates. In some localities an actual passage of beds rich in carbonates, and especially carbonate of iron, into the ferruginous rocks may be observed. The transformation of the original rocks has sometimes been accompanied by the development of actinolite and garnet. The general conclusion has been confirmed by the study of a large series of microscopic slides. The carbonates when present are always seen to be the oldest minerals in the rocks.[2] J. J. H. T.

Artificial Production of Quartz and Tridymite.—M. K. de Kroustchoff has produced finely crystallised quartz by heating a solution of silica in

---

[1] *Min. Mag.* Vol. VII. (1887), p. 161. This paper was read on May 10th, 1887, and Professor Cohen's letter to the Editor of the *Neues Jahrbuch* is dated May 1887.—J. J. H. T.

[2] The fact that silica will replace carbonate of lime is of course well known, and has been illustrated experimentally by Professor Church, who allowed a 1 p. c. solution of silicic hydrate to drop on to a coral, and found that silica was retained and carbonate of lime removed. It would be interesting to repeat Professor Church's experiments with carbonate of iron. If, as seems highly probable, a similar reaction should take place, iron oxides would be precipitated wherever the conditions were favourable to oxidation, and an association of silica and iron-oxides such as that which occurs in the Lake Superior Region would be produced. In connection with the association of amorphous silica and iron-ores, the following fact may be mentioned. If a portion of the oolitic Cleveland ore be treated with hydrochloric acid, hollow shells (like egg-shells) of silica, resembling the oolitic grains in form and size, will remain behind. These shells are readily dissolved in caustic potash. That the silica of which they are composed has been introduced in connection with the metamorphic processes to which the rock has been subjected, is proved by the fact that similar shells are not left after treating an ordinary oolitic limestone in the same way.—J. J. H. T.

Digitized by Google

pure water in a closed vessel, and maintaining it at a temperature of 250° C. for several months. He has also produced tridymite by the following two methods :—(1) Fragments of rocks rich in quartz were submitted to the action of a fused basalt or melaphyr for 1 to 6 hours. (2) Fragments of rocks rich in quartz were partially or completely fused. In these experiments the quartz is seen to break up into angular fragments, and to dissolve in the magma, either directly without further change, or after being transformed into a finely fibrous mass exhibiting aggregate polarisation, which is absorbed by the magma as by a sponge. This substance then breaks up into segments with rectilinear boundaries and completely isotropic, but at the centres of the segments brilliant particles of unaltered quartz may often be detected under crossed nicols. To this succeeds a process of complete alteration, in which the quartz is converted into a scaly mass of tridymite; these scales have the character sometimes of uniaxial and sometimes of biaxial crystals. *Bull. Soc. Min.* X. 1887, pp. 31-6, and *Neues Jahrb.* 1887 (1) pp. 205-8. H. A. M.

Twin-crystals of Garnet. (*Verh. d. Russisch. Kais. Mineralog. Ges.* 32 (1887), p. 126.) Crystals of garnet from Pitkäranta are described by A. Arzruni, which are remarkable, both as being the only known case of twinned garnet, and also as affording examples of a new twin law in the cubic system. The crystals are a combination of the dodecahedon {110} with the icositetrahedron {211}, and are twinned upon a face of the tetrakishexadron {210}. H. A. M.

Garnet from Breslau. (*Verhandl. d. k. k. geolog. Reichsantalt* 1886, p. 328.) In digging the foundations of the Theological College at Breslau, the workmen found a large number of brown garnet crystals embedded in a dark grey sand, about 10 metres from the Oder. Examination of this nest of garnets has shown that they must have been originally enclosed in a white crystalline limestone; the only other mineral which could be detected with certainty was green augite in small grains.

The crystals were found at a depth of only two metres from the surface, but many thousands were collected. Dr. Roemer believes that they were not placed in this spot by human agency; they cannot have been transported by the Oder, which at Breslau has a slow current and only carries fine sand; and the only other explanation which he suggests is that they may have been derived from a block of limestone transported by glacial action. H. A. M.

Digitized by Google

INDEX TO MINERALOGICAL PAPERS, &c. 1886.

By H. A. Miers, M.A.

Actinolite. V. Goldschmidt. Ann. Mus. Wien. i. p. 128. *Spec. Grav.*

Adularia. V. Goldschmidt. Ann. Mus. Wien. i. p. 128. *Spec. Grav.*
H. Miers. Min. Mag. vii. p. 12. *Switzerland, Cryst.*

Agalmatolite. O. Luedecke. Zts. Natwiss. Halle, v. p. 271. *Soda,—new variety.*
W. Bell. Min. Mag. vii. p. 24. *Chem.*
W. Macadam. Min. Mag. vii. p. 29. *Chem.*

Agate. H. du May. Bull. Soc. Min. ix. p. 216. *Opt. Colour.*
W. Dawkins. Trans. Man. Geol. Soc. xviii. p. 525.

Albite. A. Lacroix. Bull. Soc. Min. ix. p. 131. *Norway.*
C. Schmidt. Zs. K. xi. p. 597. *Taunus.*
C. Schmidt. Zs. K. xi. p. 603. *Windgällen.*
J. Lehmann. Zs K. xi. p. 612. *Contraction-cracks.*
M. Schuster. Min. Mitth. vii. p. 373. *Kasbek, Cryst.*
E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 9. *Stainz.*
F. Clarke. Am. J. Sc. xxxi. p. 268. *Maine, Chem.*
A. Jackson. Bull. Cal. Ac. Sc. i. p. 368. *Calaveras Co., Cryst.*

Alexandrite. G. Kunz. Science, vii. p. 399. *Gem.*

Allanite. J. Iddings and W. Cross. Chem. News, liii. p. 279. *Min.*
L. Eakins. Chem. News, liii. p. 282. *Chem.*

Almandine. W. Lewis. Min. Mag. vii. p. 9. *Zermatt.*

Alstonite. A. Becker. Zs. K. xii. p. 222. *Chem.*

America. C. Bement. Zs. K. xii. p. 179. *Min. of.*

Amethyst. A. Kundt and E. Blasius. Pogg. xxviii. p. 145. *Pyroel.*

Anatase. G. Seligmann. Zs. K. xi. p. 337. *Binnenthal, Cryst.*

Andalusite. J. Götz. N. J. Beil. Bd. iv. p. 149. *Transvaal, Chem.*

Andesite. B. Mierisch. Min. Mitth. viii. p. 180. *Vesuvius.*
G. v. Rath. Festschr. Ver. Natkund. Cassel. 1886, p. 105. *Cryst.*
D. Lovisato. Att. Ac. Linc. Rend. ii. p. 259. *Sardinia.*

Anglesite. C. Guignet. C. R. ciii. p. 875. *Art.*
W. Ramsay. Zs. K. xii. p. 217. *Refract. Index.*

Anhydrite. J. Lehmann. Zs. K. xi. p. 611. *Contraction-cracks.*
O. Mügge. N. J. 1886 (1), p. 191. *Art. twinning.*
J. Danker. N. J. Beil. Bd. iv. p. 272. *Opt.*
V. Goldschmidt. Ann. Mus. Wien. i. p. 128. *Spec. Grav.*

Digitized by Google

ANORTHITE. B. Mierisch. Min. Mitth. viii. p. 178. *Vesuvius.*
A. Lacroix. Bull. Soc. Min. ix. p. 46. *Puy de Dôme, Chem.*
ANORTHITE? J. Siemiradzki. N. J. Beil. Bd. iv. p. 195. *Ecuador, Chem.*
ANTHOPHYLLITE. A. Lacroix. C. R. cii. p. 1329. *Opt. &c.*
vid. Hydrous Anthophyllite.
ANTIMONY. O. Mügge. N. J. 1886 (1), p. 183. *Art. twinning.*
ANTIMONY-ORE. Sergère. Ann. Min. x. p. 475. *Chem.*
T. Haupt. B. H. Ztg. xlv. pp. 313, 325, 333. *Tuscany.*
APATITE. H. Vater. Zs. K. xi. p. 571. *Elasticity.*
J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 15-21. *Stainz.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 153. *N. Carolina.*
J. Woldrich. Verh. Geol. Reichs. 1886, p. 454. *Bohemia.*
B. Mierisch. Min. Mitth. viii. p. 183. *Vesuvius.*
F. Gonnard. C. R. ciii. p. 1283. *France.*
A. Ditte. Ann. Chim. Phys. viii. p. 502. *Chem.*
R. Solly. Trans. Geol. Soc. Corn. x. p. 240. *Cornwall.*
R. Bell. Proc. Can. Inst. iii. p. 294. *Canada.*
vid. Manganapatite.
APOPHYLLITE. J. Lehmann. Zs. K. xi. p. 611. *Contraction-cracks.*
ARAGONITE. J. Lehmann. Zs. K. xi. p. 611. *Contraction-cracks.*
A. Schmidt. Zs. K. xii. p. 107. *Klein-Hnilecz, Cryst.*
M. Bauer. N. J. 1886 (1), p. 62. *Calcite pseud. after.*
F. Sandberger. N. J. 1886 (1), p. 252. *Loc.*
T. Liebisch. N. J. 1886 (2), p. 65. *Opt.*
J. Danker. N. J. Beil. Bd. iv. pp. 270, 289. *Opt.*
Leuze. Jahresh. Ver. Württ. xlii. p. 63. *Calcite pseud. after.*
V. Goldschmidt. Ann. Mus. Wien. i. p. 128. *Spec. Grav.*
ARSENIOSIDERITE. F. Sandberger. N. J. 1886 (1), p. 251. *Pseud. after Chalybite.*
A. Lacroix. C. R. cii. p. 273. *Opt.;* and Bull. Soc. Min. ix. p. 3.
ARSENOLAMPRITE. C. Hintze. Zs. K. xi. p. 606. *Copiapo, New Min.;* and Ber. Nied. Ges. Bonn. 1886, p. 173.
ARGYRODITE. C. Winkler. Ber. Chem. Ges. Berl. xix. p. 510. *New Min.;* and Anz. Ak. Wien. xxiii. p. 42.
A. Weisbach. N. J. 1886 (1), p. 252, (2) p. 67. *New Min.*
ASBESTOS. R. Solly. Min. Mag. vi. p. 203. *Devonshire.*
ASTRAKANITE. O. Luedecke. Zts. Natwiss. Halle, v. p. 270. *Loc.*
AUGITE. A. Schmidt. Zs. K. xii. p. 100. *Kremnitz, Cryst.*
J. Siemiradzki. N. J. 1886 (2), p. 179. *Antilles, Chem.*
J. Siemiradzki. N. J. Beil. Bd. iv. pp. 209, 223, 224. *Ecuador, Chem.*
B. Mierisch. Min. Mitth. viii. p. 129. *Vesuvius.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 222. *New York.*
E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 15, 19. *Stainz.*
AWARUITE. W. Skey. N. Z. Inst. xviii. p. 401. *New Min.*
AXINITE. R. Solly. Min. Mag. vi. p. 203. *Cryst.*

Digitized by Google

AZORITE. L. Hubbard. Ber. Nied. Ges. Bonn. 1886, p. 219. *San Miguel.*

AZOR-PYRRHITE. L. Hubbard. Ber. Nied. Ges. Bonn. 1886, p. 214. *New Min.*

BARYTES. J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
F. Sansoni. Zs. K. xi. p. 355. *Vernasca, Cryst.*
A. Schmidt. Zs. K. xii. p. 105. *Klein-Hnilecz, Cryst.*
A. Schmidt. Zs. K. xii. p. 111. *Kotterbach, Cryst.*
J. Danker. N. J. Beil. Bd. iv. pp. 274, 286. *Opt.*
C. Guignet. C. R. ciii. p. 874. *Art.*
F. Clowes. Rep. Brit. Ass. 1885, p. 1038. *In Sandstone;* and Mid. Nat. ix. p. 48.

BARYTO-CALCITE. A. Becker. Zs. K. xii. p. 222. *Chem.*

BASTONITE. C. Klement. Min. Mitth. viii. p. 21. *Chem.*

BERYL. H. Vater. Zs. K. xi. p. 582. *Elasticity.*
J. Lehmann. Zs. K. xi. p. 611. *Contraction-cracks.*
J. Danker. N. J. Beil. Bd. iv. p. 269. *Opt.*
M. Schuster. Min. Mitth. vii. p. 455. *Ifinger, Min.*
R. Pribram Min. Mitth. viii. p. 190. *Ifinger, Chem.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 67. *N. Carolina.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 254. *Cryst.*
W. Voigt. Nachr. Ges. Wiss. Gött. 1886, pp. 93, 289. *Elasticity.*
A. Purgold. Isis (Ber.), 1885, p. 33. *Salzburg Alps.*
A. Damour. Bull. Soc. Min. ix. p. 153. *Madagascar, Chem.*
S. Penfield and D. Harper. Chem. News, liv. p. 91. *Chem.;* and Am. J. Sc. xxxii. p. 107.
G. Kunz. Science. vii. p. 399. *Gem.*
F. Gonnard. C. R. ciii. p. 1283. *France.*
J. Joly. Proc. Roy. Dub. Soc. v. p. 48. *Glencullen.*

BIELZITE. G. Benks and K. Jahn. Verh. Sieb. Ver. xxxvi. p. 85. *New Resin.*

BISMUTH. O. Mügge. N. J. 1886 (1), p. 183. *Art. twinning.*

BLENDE. L. Sipöcz. Zs. K. xi. p. 216. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 102.
J. Lehmann. Zs. K. xi. p. 609. *Contraction-cracks.*
F. Pfaff. Zs. K. xii. p. 180. *Hardness.*
W. Ramsay. Zs. K. xii. p. 218. *Refract. Index.*
A. Schmidt. Zs. K. xii. p. 104. *Zipser Com. Cryst.*
C. John. Jahrb. Geol. Reichs. xxxvi. p. 346. *Chem.*
Oppermann. Ann. Min. x. p. 443. *Chem.*
Nentien. Ann. Min. x. p. 462. *Chem.*

BLOEDITE. O. Luedecke. Zts. Natwiss. Halle, v. p. 157. *Cryst.*

BOTRYOGEN. J. Hockauf. Zs. K. xii. p. 240. *Mon.*

BOURNONITE. L. Sipöcz. Zs. K. xi. p. 218. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 105.
C. Hintze. Zs. K. xi. p. 606. *On Galena.*
F. Sandberger. N. J. 1886 (1), p. 90. *S. America.*

Digitized by Google

BOURNONITE. F. Sandberger. N. J. 1886 (1), p. 177. *Alteration products.*

BRAUNITE. C. Schmidt. Zs. K. xi. p. 603. *Windgällen.*

M. Schuster. Min. Mitth. vii. p. 443. *Jakobsberg, Cryst.*

BROOKITE. S. Penfield. Am. J. Sc. xxxi. p. 387. *Arkansas. Cryst.*

E. Dana. Am. J. Sc. xxxi. p. 314. *Arkansas, Cryst.*

BROCHANTITE. J. Cooper. Bull. Washb. Lab. i. p. 170. *Arizona.*

BRUIACHITE. W. Macadam. Min. Mag. vii. p. 42. *New Min.*

BRUCITE. A. Cathrein. Zs. K. xii. p. 34. *Canzocoli.*

BULGARIA. L. Thonard. Rev. d. Min. xix. p. 1. *Min. of.*

CALAMINE. Drasche and C. John. Jahrb. Geol. Reichs. xxxvi. p. 346. *Chem.*

G. Cesaro. Bull. Soc. Min. ix. p. 242. *Cryst.*

A. Griffiths and S. Dreyfus. Chem. News, liv. p. 67. *Siberia, Chem.*

CALCITE. F. Sansoni. Zs. K. xi. p. 352. *Blaton. Cryst.*

J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*

H. Vater. Zs. K. xi. p. 570. *Elasticity.*

A. Schmidt. Zs. K. xii. p. 103. *Zipser Com.*

A. Schmidt. Zs. K. xii. p. 109. *Kotterbach, Cryst.*

M. Bauer. N. J. 1886 (1), p. 62. *Pseud. after Aragonite.*

T. Liebisch. N. J. 1886 (2), p. 64. *Opt.*

F. Schalch. N. J. Beil. Bd. iv. p. 187. *Chalybite pseud. after.*

J. Danker. N. J. Beil. Bd. iv. pp. 263, 281. *Opt.*

G. Thürling. N. J. Beil. Bd. iv. p. 327. *Andreasberg, Cryst.*

Leuze. Jahresh. Ver. Württ. xlii. pp. 63, 66. 68. *Pseud. after Aragonite, Gypsum, Glauberite, Thenardite.*

Leuze. Jahresh. Ver. Württ. xlii. pp. 62, 63, 64. *Quartz, Chalybite, Hyalite, pseud. after.*

B. Mierisch. Min. Mitth. viii. p. 125. *Vesuvius.*

E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 16. *Stainz.*

A. Purgold. Isis. (Ber.) 1885, p. 31. *Hüttenberg.*

H. v. Foullon. Verh. Geol. Reichs. 1886, p. 464. *Tyrol*

V. Goldschmidt. Ann. Mus. Wien. i. p. 128. *Spec. Grav.*

G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 189. *Rhisnes.*

L. Bourgeois. C. R. ciii. p. 1089. *Art.*

J. Conroy. Proc. Roy. Soc. xl. p. 173. *Opt.*

G. Cesaro. Bull. Soc. Min. ix. p. 281. *Cryst.*

R. Solly. Min. Mag. vi. p. 203. *Devonshire.*

Sollas. Proc. Roy. Dub. Soc. v. p. 73. *On Sponge.*

CALCO-URANITE. F. Sandberger. N. J. 1886 (1), p. 250. *Fichtelgebirge.*

CALEDONITE. G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 66. *Sardinia.*

J. Cooper. Bull. Washb. Lab. i. p. 170. *New Mexico.*

D. Lovisato. Alt. Ac. Linc. Rend. ii. p. 257. *Sardinia.*

CANCRINITE. F. Clarke. Am. J. Sc. xxxi. p. 263. *Maine, Chem.*

CARACOLITE. M. Websky. Ber. Ak. Berl. 1886, p. 1045. *New Min.*

CARINTHIA. A. Brunlechner. Jahrb. L. Mus. Kärnt. xviii. p. 74. *Min. of.*

CARPHOSIDERITE. A. Lacroix. C. R. ciii. p. 1037. *Macon, Opt.*

Digitized by Google

CAS-ITERITE.	O. Pufahl. B. H. Ztg. xlv. p. 173. *With Gold, Australia.*
	G. Cesaro. Bull. Soc. Min. ix. p. 220. *Cryst.*
	C. John. Jahrb. Geol. Reichs. xxxvi. p. 346. *Chem.*
CASTOR.	A. Purgold. Isis (Ber.), 1885, p. 32. *Elba.*
CELESTINE.	C. Hintze. *Zs. K.* xi. p. 220. *Lüneburg, Cryst.*
	J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
	T. Liweh. Zs. K. xii. p. 439. *Lüneburg, Cryst.*
	C. Bärwald. Zs. K. xii. p. 228. *Cryst. Chem.*
	Leuze. Jahresh. Ver. Württ. xlii. p. 63. *Quartz pseud. after.*
CERARGYRITE.	F Sandberger. N. J. 1886 (1), p. 89. *Caracoles.*
CERUSSITE.	W. Brown. Am. J. Sc. xxxii. p. 377. *Art.*
	L. Bourgeois. C. R. ciii. p. 1089. *Art.*
CHALCANTHITE.	F. Sandberger. N. J. 1886 (1), p. 178. *Chili.*
	J. Cooper. Bull. Washb. Lab. i. p. 170. *Arizona.*
CHALILITE.	A. Lacroix. C. R. cii. p. 645. *Opt.*; and Bull. Soc. Min. ix. p. 80.
CHALYBITE.	F. Sandberger. N. J. 1886 (1), p. 251. *Arseniosiderite pseud. after.*
	Leuze. Jahresh. Ver. Württ. xlii. p. 63. *Pseud. after Haematite and Calcite.*
	J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
	F. Schalch. N. J. Beil. Bd. iv. p. 187. *Pseud. after Calcite.*
CHESSYLITE.	F. Sandberger. N. J. 1886 (1), p. 179. *Argentine Rep.*
CHILI.	J. Kerr. Min. Mag. vii. p. 18. *Min. of.*
CHLOANTHITE.	H. Baumhauer. Zs. K. xii. p. 18. *Cryst.*
CHLORITE.	E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 13. *Stainz.*
CHLORITOID.	A. Lacroix. Bull. Soc. Min. ix. p. 42. *Opt.*
CHONDRODITE.	B. Mierisch. Min. Mitth. viii. p. 141. *Vesuvius.*
	E. Mallard. Bull. Soc. Min. ix. p. 84. *Cryst.*
	A. Michel-Levy and A Lacroix. Bull. Soc. Min. ix. p. 81. *Opt.*
CHROMITE.	H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 346. *Chem.*
CHRYSOBERYL.	G. Kunz. Science, vii. p. 399. *Gem.*
CHRYSOCOLLA.	E. Jannettaz. Bull. Soc. Min. ix. p. 211. *California. Chem.*
CLAY.	J. Strohecker. J. Prakt. Chem. xxxiii p. 132. *Cont. Ce, &c.*; and Chem. News, liii. p. 136, liv. pp. 7, 207.
	C. Blomstrand. J. Prakt. Chem. xxxiii. p. 483. *Cont. Ce.*
COALS.	A. Taylor. Min. Mag. vii. p. 13. *Nomenclature.*
COCCOLITE.	A. Cathrein. Zs. K. xii. p. 34. *Viezena.*
COLEMANITE.	A. Jackson. Bull. Cal. Ac. Sc. i. p. 358. *Cryst.*
COLUMBITE.	E. Dana. Am. J. Sc. xxxii. p. 386. *Cryst.*; and Zs. K. xii. p. 266.
COPPER.	E. Dana. Am. J. Sc. xxxii. p. 413. *Cryst.*
COPPER PYRITES.	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 192. *Bolivia.*
	Oppermann. Ann. Min. x. p. 444. *Chem.*
	H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 345. *Chem.*

Digitized by Google

COPPER ORE. H. Becher. Q. J. Geol. Soc. xlii. p. 494. *China.*
Béchevel. Ann. Min. x. p. 433. *Chem.*
Nentien. Ann. Min. x. p. 461. *Chem.*
Sergère. Ann. Min. x. p. 476. *Chem.*

COQUIMBITE. F. Sandberger. N. J. 1886 (1), p. 178. *Chili.*

CORDIERITE. E. Scacchi. Att. Ac. Linc. Rend. ii. p. 183. *Tuscany.*
J. Joly. Proc. Roy. Dub. Soc. v. p. 48. *Glencullen.*

CORUNDUM. O. Mügge. N. J. 1886 (1), p. 146. *Twinning.*
B. v. Camerlander. Verh. Geol. Reichs. 1886, p. 256. *Silesia.*

COUSERANITE. C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*

CRISTOBALITE. G. v. Rath. Verh. Nat. Ver. Rheinl. xxxiv. corr. bl. p. 121 *New Min.*

CROCOISITE. F. Sandberger. N. J. 1886 (1), p. 90. *S. America.*

CRYOLITE. F. Oettel. Isis. (Ber.) 1885, p. 29. *Art.*

CRONSTEDTITE. H. v. Foullon. Verh. Geol. Reichs. 1886, p. 468. *Kuttenberg.*

CRYSTALS. H. Vater. Zs. K. xi. p. 549. *Elasticity.*
J. Lehmann. Zs. K. xi. p. 608. *Contraction-cracks.*
W. Ramsay. Zs K. xii. p. 209. *Refract. Index.*
O. Lehmann. Zs. K. xii. p. 377. *Growth of, &c.*
J. Beckenkamp. Zs. K. xii. p. 419. *Elasticity of.*
B. Minnigerode. N. J. 1886 (1), p. 7. *Therm. Math.*
T. Liebisch. N. J. 1886 (1), pp. 14, 155. *Opt. Math.*
O. Mügge. N. J. 1886 (1), p. 136. *Secondary twinning.*
P. Volkmann. N. J. 1886 (1), p. 205. *Reflexion, Math.*
A. Schrauf. N. J. 1886 (1), p. 234. *Morphotropy, &c.*
T. Liebisch. N. J. 1886 (2), p. 47. *Reflexion.*
J. Danker. N. J. Beil. Bd. iv. p. 241. *Reflexion.*
K. Schmidt. Pogg. xxix. p. 451. *Reflexion.*
W. Voigt. Pogg. xxix. p. 604. *Torsion.*
E. Ketteler. Pogg. xxviii. pp. 230, 520. *Reflexion.*
A. Schrauf. Pogg. xxviii. p. 433. *Therm. Opt.*
E. Mallard. Bull. Soc. Min. ix. p. 54. *Opt. anomalies.*
G. Wyrouboff. Bull. Soc. Min. ix. p. 102. *Isomorphism.*
E. Mallard. Bull. Soc. Min. ix. p. 115. *Isomorphism.*
E. Mallard. Bull. Soc. Min. ix. p. 154. *Reflexion.*
G. Cesaro. Bull. Soc. Min. ix. p. 222. *Twinning.*
G. Wyrouboff. Ann. Chim. Phys. viii. p. 340. *Circular Pol.*
E. Ferron. Publ. Inst. Lux. xx. pp. 1, 49. *Opt. Math.*
C. d'Huart. Publ. Inst. Lux. xx. p. 61. *Opt. Math.*
T. Kjerulf. Forh. Vid. Sels. Christ. 1885, 16. *Opt. Sign.*
W. Barlow. Chem. News, liii. pp. 3, 16. *Symmetry;* and Rep. Brit. Ass. 1885, p. 983.

CRYSTALLOGRAPHY. B. Hecht. Zs. K. xi. p. 531. *Math.*
A. Schrauf. Zs. K. xii. p. 175. *Math.*
R. Prendel. Zs. K. xii. p. 460. *Hemihedrism.*
H. Miers. Zs. K. xii. p. 462. *Math.*
C. Brown. Proc. Roy. Soc. Ed. xiii. p. 118. *Hexag. System.*

CUPRO-URANITE. F. Sandberger. N. J. 1886 (1), p. 250. *Fichtelgebirge.*

Digitized by Google

CYANITE. M. Websky. Zts. Geol. Ges. xxxviii. p. 473. *Georgia.*

DANBURITE. M. Schuster. Min. Mag. vi. p. 213. *Cryst.*
DATOLITE. R. Riechelmann. Zs. K. xii. p. 436. *Seisser Alp, Cryst.*
L. Bombicci. Mem. Ac. Bol. vii. p. 101. *Cryst.*; and Rendic. Ac. Bol. 1886, p. 42.
DAVREUXITE. A. Lacroix. C. R. cii. p. 273. *Opt.*; and Bull. Soc. Min. ix. p. 5.
DESCLOIZITE. A. Des Cloizeaux. Zs. K. xii. p. 178. *Cryst. Opt.*; and Bull. Soc. Min. ix. p. 138.
DESMINE. L. Langemann. N. J. 1886 (2), p. 126. *Mon.*
DIAMOND. A. Schrauf. N. J. 1886 (1), p. 93. *Opt.*
N. Chatrian. Bull. Soc. Min. ix. p. 302. *Salobro, Min.*
DIASPORE. E. Dana. Am. J. Sc. xxxii. p. 388. *Cryst.*; and Zs. K. xii. p. 459.
DIOPSIDE. J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
G. Flink. Zs. K. xi. p. 449. *Nordmark, Cryst. &c.*
J. Götz. Zs. K. xi. p. 236. *Cryst.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 222. *De Kalb, Cryst.*
O. Mügge. N. J. 1886 (1), p. 185. *Art. twinning.*
DIPYRE. C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
DOGNACSKA. vid. Moravica.
DOLOMITE. J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
J. Danker. N. J. Beil. Bd. iv. p. 285. *Opt.*
H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 347. *Chem.*
DUBLIN. W. O'Neill. Sci. Goss. xxii. p. 205. *Min. of.*

ELAEOLITE. F. Sandberger. N. J. 1886 (1), p. 89. *Caracoles.*
EMBOLITE. J. Munro. Chem. News, liii. p. 99. *Victoria, Chem.*
J. Welch. Chem. News, liv. pp. 94, 162. *Chem.*
ENDLICHITE. F. Genth and G. v. Rath. Chem. News, liii. p. 218. *Lake Valley.*
ENHYDROS. Nies. Jahresh. Ver. Württ. xlii. p. 57.
EPIDOTE. J. Götz. N. J. Beil. Bd. iv. p. 127. *Transvaal, Chem.*
EPSOMITE. E. Priwosznik. Berg. u. Hütt. Jahrb. 1886, 3. *Min.*
ERZGEBIRGE. F. Scalch. N. J. Beil. Bd. iv. p. 178. *Min. of.*
ESTLAND. vid. Kurland.
EUCLASE. R. Köchlin. Ann. Mus. Wien. i. p. 237. *Austria.*
A. Purgold. Isis (Ber). 1885, p. 32. *Glockner.*
EUDIALYTE. C. Rammelsberg. Zts. Geol. Ges. xxxviii. p. 497. *Chem* and Ber. Ak. Berl. 1886, p. 441.

FELSPAR. J. Judd. Q. J. Geol. Soc. xlii. p. 64. *Mull, Chem.*
H. Miers. Min. Mag. vii. p. 10. *Kilima-njaro.*
J. Siemiradzki. N. J. Beil. Bd. iv. p. 209. *Ecuador, Chem*
O. Mügge. N. J. Beil. Bd. iv. p. 591. *Masai-land.*

Digitized by Google

FELSPAR. E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 3. *Stains.*
R. Bréon. C. R. ciii. p. 170. *Anorthic, Min.*
FLUOR. W. Voigt. N. J. Beil. Bd. iv. p. 228. *Elasticity.*
R. Solly. Min. Mag. vi. p. 202. *Callington.*
J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
FORSTERITE. B. Mierisch. Min. Mitth. viii. p. 139. *Vesuvius.*
G. Strüver. Att. Ac. Linc. Rend. ii. p. 459. *Baccano, Cryst.*
GADOLINITE. W. Crookes. Proc. Roy. Soc. xl. p. 502. *Chem;* and Chem. News, liv. p. 13.
L. Eakins. Chem. News, liii. p. 282. *Chem.*
F. Eichstädt. Bih. Vet. Ak. Hand. x. 18. *Cryst.*
GALENA. Oppermann. Ann. Min. x. p. 443. *Chem.*
Sergère. Ann. Min. x. p. 474. *Chem.*
Nentien. Ann. Min. x. p. 462. *Chem.*
C. Grewingk. Ber. Nat. Ges. Dorp. viii. p. 84. *Livland.*
O. Mügge. N. J. 1886 (1), p. 191. *Art. twinning.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 34. *Mimetite pseud. after.*
H. Foullon. Jahrb. Geol. Reichs. xxxvi. p. 345. *Chem.*
GARNET. A. Cathrein. Zs. K. xii. p. 35. *Canzocoli.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 36. *Salides.*
v. Dechen. Ber. Nied. Ges. Bonn. 1886, p. 261. *Breslau.*
A. Cathrein. N. J. 1886 (1), p. 84. *Oetzthal, Min.*
F. Roemer. Zts. Geol. Ges. xxxviii. p. 723. *Breslau;* and Verh. Geol. Reichs. 1886, p. 403.
A. Sauer. Zts. Geol. Ges. xxxviii. p. 705. *Waldheim.*
C. Klement. Min. Mitth. viii. p. 18. *Chem.*
B. Mierisch. Min. Mitth. viii. p. 143. *Vesuvius.*
F. Gonnard. C. R. ciii. p. 654. *Puy de-Dôme.*
E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 14, 21. *Stainz.*
A. Gehmacher. Ann. Mus. Wien. i. p. 233. *Ekbatana, &c.*
E. Scacchi. Att. Ac. Linc. Rend. ii. p. 182. *Tiriolo.*
R. Solly. Min. Mag. vi. p. 202. *Devonshire.*
W. Cross. Am. J. Sc. xxxi. p. 432. *Nathrop.*
GAYLUSSITE. E. Geinitz. Isis (Ber.) 1885, p. 28. *Art.*
GERSDORFFITE. L. Sipöcz. Zs. K. xi. p. 213. *Chem.*
GIOBERTITE. L. Bourgeois. C. R. ciii. p. 1090. *Art.*
GLAUBERITE. Leuze. Jahresh. Ver. Württ. xlii. p. 65. *Pseud.*
GLAUCOPHANE. K. Oebbeke. Zs. K. xii. p. 282. *Localities;* and Zts. Geol. Ges. xxxviii. p. 634.
T. Bonney. Min. Mag. vii. p. 1. *Val d'Aoste.*
GOETHITE. J. Welch. Chem. News, liii. p. 79. *Chem.*
GOLD. A. Gehmacher. Ann. Mus. Wien. i. p. 233. *Ekbatana, &c.*
E. Dana. Zs. K. xii. p. 275. *Cryst.;* and Am. J. Sc. xxxii. p. 132.
Landsberg. Verh. Nat. Ver. Rheinl. xxxiv. corr. bl. p. 63 *Brazil.*

Digitized by Google

GOLD, R. Romanis. Chem. News, liv. p. 278. *Burma, Min.*

GRAPHITE. Le Verrier. Ann. Min. x. p. 455. *Chem.*

H. v. Foullon. Jahrb. Geol. Reichs. xxxvi. p. 341. *Chem.*

GREENOCKITE. F. Sandberger. N. J. 1886 (1), p. 251. *Briton and Neu-sinka.*

GRÜNERITE. A. Lacroix. C. R. cii. p. 643, *Opt.*; and Bull. Soc. Min. ix. p. 40.

GUANAJUATO. G. v. Rath. Verh. Nat. Ver. Rheinl. xxxiv. corr. bl. p. 97. *Min. of.*

GUEJARITE. F. Sandberger. N. J. 1886 (1), p. 89. *Bolivia.*

GYPSUM. S. Meunier. C. R. cii. p. 1406. *Min.*

A. Des Cloizeaux. Bull. Soc. Min. ix. p. 175. *Cryst.*

J. Lehmann. Zs. K. xi. p. 611. *Contraction-cracks.*

J. Danker. N. J. Beil. Bd. iv. p. 230. *Opt.*

F. Cragin. Bull. Washb. Lab. i. p. 166. *Kansas.*

Leuze. Jahresh. Ver. Württ. p. 63. *Quartz pseud. after.*

Leuze. Jahresh. Ver. Württ. xlii. p. 66. *Calcite pseud. after.*

HAEMATITE. O. Mügge. N. J. 1886 (2), p. 35. *Secondary twinning.*

F. Schalch. N. J. Beil. Bd. iv. p. 193. *Magnetite pseud. after.*

Leuze. Jahresh. Ver. Württ. xlii. p. 63. *Chalybite pseud. after.*

G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 36. *Durango.*

G. Strüver. Att. Ac. Linc. Rend. ii. (2), p. 331. *Magnetite pseud. after.*

J. Welch. Chem. News, liii. p. 52. *Chem.*

W. Gresley. Mid. Nat. ix. pp. 1, 33, 64, 92. *Nodules.*

E. Geinitz. Isis (Ber.), 1885, p. 29. *Art.*

HALLOYSITE. Oppermann. Ann. Min. x. p. 448. *Chem.*

HARMOTOME. L. Langemann. N. J. 1886 (2), p. 83. *Mon.*

J. Joly. Proc. Roy. Dub. Soc. v. p. 165. *Wicklow.*

HARSTIGITE. W. Ramsay. Zs. K. xii. p. 220. *Refract. Index.*

HAUYNE. B. Mierisch. Min. Mitth. viii. p. 167. *Vesuvius.*

HEMIMORPHITE. F. Schalch. N. J. Beil. Bd. iv. p. 187. *Erzgebirge.*

HERDERITE. A. Purgold. Isis (Ber.), 1885, p. 32. *Stoneham.*

A. Des Cloizeaux. Bull. Soc. Min. ix. p. 141. *Opt.*

S. Penfield and D. Harper. Am. J. Sc. xxxii. p. 107. *Chem.*; and Chem. News, liv. p. 90.

W. Hidden. Am. J. Sc. xxxii. p. 209. *Cryst.*

HEULANDITE. V. Goldschmidt. Ann. Mus. Wien. i. p. 129. *Spec. Grav.*

HORNBLENDE. J. Götz. N. J. Beil. Bd. iv. p. 126. *Transvaal, Chem.*

J. Siemiradzki. N. J. Beil. Bd. iv. p. 209. *Ecuador, Chem.*

K. Oebbeke. Zs. K. xi. p. 368. *Mt. Dore, Cryst.*

B. Mierisch. Min. Mitth. viii. p. 174. *Vesuvius.*

E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 14. *Stainz.*

J. Kloos. N. J. 1886 (1), p. 211. *Chem.*; and Jahresh. Ver. Württ. xlii. p. 321.

HORNSTONE. R. Solly. Min. Mag. vi. p. 203. *Devonshire.*

Digitized by Google

HUMBOLDTILITE.	B. Mierisch. Min. Mitth. viii. p. 149. *Vesuvius.*
	C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
HUMITE.	B. Mierisch. Min. Mitth. viii. p. 141. *Vesuvius.*
	A. Levy and A. Lacroix. Bull. Soc. Min. ix. p. 81. *Opt.*
	E. Mallard. Bull. Soc. Min. ix. p. 84. *Cryst.*
HUNGARY.	L. Sipöcz. Zs. K. xi. p. 210. *Min. of.*
	A. Schmidt. Zs. K. xii. p. 97. *Min. of.*
HYALITE.	Leuze. Jahresh. Ver. Württ. xlii. p. 64. *Pseud. after Calcite and Quartz.*
HYDROCERUSSITE.	L. Bourgeois. C. R. ciii. p. 1089. *Art.*
HYDRONEPHELITE.	F. Clarke. Am. J. Sc. xxxi. p. 265. *Maine, New Min.*
HYDROTEPHROITE.	A. Lacroix. C. R. cii. p. 274. *Opt;* and Bull. Soc. Min. ix. p. 6.
HYDROUS ANTHOPHYLLITE.	A. Lacroix. C. R. cii. p. 274. *Opt.;* and Bull. Soc. Min. ix. p. 7.
HYPERSTHENE.	K. Oebbeke. Zs. K. xi. p. 367. *Mt. Dore, Cryst.*
	A. Schmidt. Zs. K. xii. p. 97. *Mt. Pokhausz, Cryst,*
	J. Siemiradzki. N. J. Beil. Bd. iv. p. 214. *Ecuador, Chem.*
ICE.	A. Kenngott. N. J. 1886 (2), p. 184. *Cryst.*
IDOCRASE.	C. Rammelsberg. Zts. Geol. Ges. xxxviii. p. 507. *Chem.*
	B. Mierisch. Min. Mitth. viii. p. 137. *Vesuvius.*
	W. Lewis. Min. Mag. vii. p. 9. *Zermatt.*
	L. Igelström. Bull. Soc. Min. ix. p. 22. *Jacobsberg, Manganif.*
IDRIA.	F. Friese. Verh. Geol. Reichs. 1886, p. 431. *Min.*
ILMENITE.	A. Cathrein. Zs. K. xii. p. 40. *Growth with Magnetite.*
IODYRITE.	F. Genth and G. v. Rath. Chem. News, liii. p. 218. *Lake Valley.*
	F. Sandberger. N. J. 1886 (1), p. 89. *Caracoles.*
IRELAND.	G. Kinahan. Proc. Roy. Dub. Soc. v. p. 200. *Min. of.*
IRON-ORES.	Le Verrier. Ann. Min. x. p. 463. *Chem.*
	Nentien. Ann. Min. x. p. 463. *Chem.*
	Tingry. Ann. Min. x. p. 466. *Chem.*
	Sergère. Ann. Min. x. p. 474. *Chem.*
	Poncelet. Ann. Min. x. p. 480. *Chem.*
	De Grossouvre. Ann. Min. x. p. 311. *France.*
	H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 342. *Chem.*
	R. Irving. Am. J. Sc. xxxii. p. 255. *Origin of.*
JADE.	J. White. Chem. News, liv. p. 20. *Mogaung, Chem.*
JASPER.	R. Solly. Min. Mag. vi. p. 203. *Devonshire.*
JEFFERSONITE ?	vid. Hornblende. (J. Kloos.)
KALICITE.	C. Grewingk. Ber. Nat. Ges. Dorp. viii. p. 50. *Dorpat.*
KALIOPHILITE.	B. Mierisch. Min. Mitth. viii. p. 157. *New Min.*
KOBELLITE.	H. F. and H. A. Keller. N. J. 1886 (2), p. 79. *New variety.*

Digitized by Google

KOPPITE.	G. Bailey. J. Chem. Soc. 1886, p. 153. *Chem.*; and Lieb. Ann. ccxxxii. p. 357.
KRENNERITE.	L. Sipőcz. Zs. K. xi. p. 210. *Chem.*; and Ber. Chem. Ges. Berl. xix. p. 96.
KRYPTOLITE.	A. Sauer. Zts. Geol. Ges. xxxviii. p. 705. *New Min.*
KURLAND.	C. Grewingk. Ber. Nat. Ges. Dorp. viii. p. 43. *Min. of.*
LABRADORITE.	V. Goldschmidt. Ann. Mus. Wien. i. p. 129. *Spec. Grav.*
LANGITE.	H. v. Foullon. Verh. Geol. Reichs. 1886, p. 465. *Chem.*
LAUMONTITE.	F. Scalch. N. J. Beil. Bd. iv. p. 184. *Erzgebirge.*
LEADHILLITE.	D. Lovisato. Att. Ac. Linc. Rend. ii. p. 256. *Sardinia.*
LEAD-ORE.	Poncelet. Ann. Min. x. p. 479. *Chem.*
LEPIDOLITE.	F. Clarke. Am. J. Sc. xxxii. p. 353. *Chem.*
	R. Scharizer. Zs. K. xii. p. 1. *Twinning of.*
LEPIDOMELANE.	F. Clarke. Am. J. Sc. xxxi. p. 268. *Maine, Chem.*
LEUCITE.	V. Goldschmidt. Ann. Mus. Wien. i. p. 129. *Spec. Grav.*
	B. Mierisch. Min. Mitth. viii. p. 153. *Vesuvius.*
LIMONITE.	E. Smith. Am. J. Sc. xxxi. p. 376. *Pseud. after Pyrites.*
	J. Meem. Am. J. Sc. xxxii. p. 274. *Pseud. after Pyrites.*
	J. Welch. Chem. News, liii. p. 65. *Chem.*
	Oppermann. Ann. Min. x. p. 445. *Chem.*
LITCHFIELD.	F. Clarke. Am. J. Sc. xxxi. p. 262. *Maine, Min. of.*
LIVLAND.	Vid. Kurland.
LUCASITE.	T. Chatard. Am. J. Sc. xxxii. p. 375. *New Min.*
MAGNETITE.	J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
	A. Cathrein. Zs. K. xii. p. 37. *Scalotta, Chem.*
	A. Cathrein. Zs. K. xii. p. 40. *Growth with Ilmenite.*
	A. Cathrein. Zs. K. xii. p. 47. *Twinning.*
	F. Hornstein. N. J. 1886 (1), p. 253. *Magnetic.*
	F. Schalch. N. J. Beil. Bd. iv. p. 193. *Pseud. after Haematite.*
	G. Struver. Att. Ac. Linc. Rend. ii. (2), p. 331. *Pseud. after Haematite.*
	Scheibe. Zts. Geol. Ges. xxxviii. p. 469. *Cryst.*
MALACHITE.	F. Sandberger. N. J. 1886 (1), p. 179. *Argentine Rep.*
	L. Bourgeois. C. R. ciii. p. 1090. *Art.*
MANGAN-APATITE.	F. Sandberger. N. J. 1886 (1), p. 89. *Saxony.*
MANGANESE-ORES.	H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 344. *Chem.*
	Le Verrier. Ann. Min. x. p. 453. *Chem.*
	Nentien. Ann. Min. x. p. 463. *Chem.*
	Sergère. Ann. Min. x. p. 474. *Chem.*
	Götting. B. H. Ztg. xlv. p. 345. *Bosnia, Min.*
MANGANITE.	R. Brauns. N. J. 1886 (1), p. 252. *Oberstein.*
MANGANOSTIBIITE.	A. Kenngott. N. J. 1886 (2), p. 185. *Chem.*
MARCASITE.	E. Palla. Verh. Geol. Reichs. 1886, p. 266. *Marienbad.*
	C. Grewingk. Ber. Nat. Ges. Dorp. viii. p. 83. *Estland.*

Digitized by Google

MARIALITE.	C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
MARTITE.	F. Schalch. N. J. Beil. Bd. iv. p. 189. *Rittersgrün.*
MEIONITE.	C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
	B. Mierisch. Min. Mitth. viii. p. 148. *Vesuvius.*
MELILITE.	B. Mierisch. Min. Mitth. viii. p. 152. *Vesuvius.*
MICA.	K. Oebbecke. Zs. K. xi. p. 257. *Meran.*
	J. Lehmann. Zs. K. xi. p. 611. *Contraction-cracks.*
	R. Scharizer. Zs. K. xii. p. 11. *Regular growths of.*
	R. Scharizer. Zs. K. xii. p. 15. *Schüttenhofen, Chem.*
	B. Mierisch. Min. Mitth. viii. p. 132. *Vesuvius.*
	E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 12, 21. *Stainz.*
	J. Woldrich. Verh. Geol. Reichs. 1886, p. 455. *Bohemia.*
MICROCLINE.	K. Oebbeke. Zs. K. xi. p. 256. *Meran.*
	E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 6. *Stainz.*
MICROLITE.	F. Feist. Zs. K. xi. p. 255. *Virginia, Cryst.*
MICROSOMMITE.	B. Mierisch. Min. Mitth. viii. p. 161. *Vesuvius.*
MILARITE.	W. Ramsay. Öfv. Vet. Ak. Förh. 1885, 9, p. 29. *Cryst. Opt.*
MIMETITE.	P. Jeremejew. Verh. Russ. Min. Ges. xxii. p. 179. *Nertschinsk.*
	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 36. *Pseud. after Galena.*
MINERALS.	V. Goldschmidt. Ann. Mus. Wien. i. p. 127. *Spec. Grav.;* and Verh. Geol. Reichs. 1886, p. 439.
	P. Oberg. Öfv. Vet. Ak. Förh. 1885, 8, p. 43. *Spec. Heat.*
	J. Joly. Proc. Roy. Dub. Soc. v. p. 41. *Spec. Grav.*
	J. Joly. Chem. News, liv. p. 279. *Spec. Heat.*
	J. Thoulet. Rev. Sci. xxxvii. p. 136. *Biology of.*
	J. Kerr. Min. Mag. vii. p. 18. *Formulæ of.*
	R. Brauns. N. J. 1886 (2), p. 72. *Separation, &c.*
	T. Behrens. Chem. News, liv. pp. 196-316. *Microchemical.*
	T. Hunt. Can. Rec. ii. p. 116. *Classification.*
MINERAL VEINS.	A. v. Groddeck. Rev. d. Min. xix. p. 251.
MISPICKEL.	A. Schmidt. Zs. K. xii. p. 102. *Zipser Com., Cryst.*
	A. Schmidt. Zs. K. xii. p. 115. *Klenocz, Cryst.*
	R. Solly. Min. Mag. vi. p. 203. *Devonshire.*
MIZZONITE.	C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
MOLYBDENITE.	W. Hidden. Am. J. Sc. xxxii. p. 210. *Cryst.*
	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 67. *Oliena.*
	D. Lovisato. Att. Ac. Linc. Rend. ii. p. 258. *Sardinia.*
MONAZITE.	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 149. *N. Carolina, Cryst.*
	R. Scharizer. Zs. K. xii. p. 255. *Schüttenhofen;* and Verh. Geol. Reichs. 1886, p. 283.
	W. Hidden. Am. J. Sc. xxxii. p. 207. *N. Carolina.*
MONT DORE.	K. Oebbeke. Zs. K. xi. p. 365. *Min. of.*
MORAVICA.	H. Sjögren. Jahrb. Geol. Reichs. xxxvi. p. 607. *Min. of.*
NAGYAGITE.	L. Sipöcz. Zs. K. xi. p. 211. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 97.

Digitized by Google

NATROLITE.	V. Goldschmidt. Ann. Mus. Wien. i. p. 130. *Spec. Grav.*
	O. Luedecke. Zts. Natwiss. Halle, v. p. 390. *Clausthal.*
NEPHELINE.	B. Mierisch. Min. Mitth. viii. p. 156. *Vesuvius.*
NEPHRITE ?	A. Törnebohm. N. J. 1886 (2), p. 191. *Sweden.*
	A. Meyer. N. J. 1886 (2), p. 255. *Sweden.*
NEW MINERALS.	W. Dawson. Min. Mag. vi. p. xviii. *Lead Chromate.*
	K. de Kroustchoff. Bull. Soc. Min. ix. p. 85. *Spinel.*
	K. de Kroustchoff. Bull. Soc. Min. ix. p. 143. *Beucha.*
	A. Des Cloizeaux. Bull. Soc. Min. ix. p. 184. *Titanium Oxide.*
	A. Lacroix. Bull. Soc. Min. ix. p. 51. *Peru, Oxalate.*
	A. Piccini. Att. Ac. Linc. Rend. ii. (2), p. 46. *Craveggia.*
	vid. Agalmatolite, Argyrodite, Arsenolamprite, Awaruite, Azorpyrrhite, Bielzite, Bruiachite, Caracolite, Cristobalite, Endlichite, Harstigite, Hydronephelite, Kobellite, Kryptolite, Lucasite, Polyarsenite, Prismatine, Ptilolite, Pyrrho-arsenite, Schungite, Spinel.
NICCOLITE.	L. Sipőcz. Zs. K. xi. p. 215. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 101.
NICKEL-ORE.	L. Sipőcz. Zs. K. xi. p. 214. *Chem. Dobsina;* and Ber. Chem. Ges. Berl. xix. p. 100.
NITRATINE.	J. Kerr. Min. Mag. vii. p. 21.
NITRE.	C. Ochsenius. Zts. Geol. Ges. xxxviii. p. 911. *Chili.*
N. CAROLINA.	W. Hidden. Am. J. Sc. xxxii. p. 204. *Min. of.*
OLIVINE.	B. Mierisch. Min. Mitth. viii. p. 139. *Vesuvius.*
	G. v. Rath. Ber. Nied. Ges. 1886, p. 194. *Yellowstone Pk.*
ORTHITE.	G. Linnemann. Ber. Ak. Wien, xciii. (2), p. 662. *Chem.*
ORTHOCLASE.	A. Des Cloizeaux. Zs. K. xi. p. 605. *Elba, Cryst.*
	J. Lehmann. Zs. K. xi. p. 612. *Contraction-cracks.*
	A. Cathrein. Zs. K. xii. p. 35. *Mulat, Cryst.*
	E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 17. *Stains.*
	A. Purgold. Isis (Ber.), 1885, p. 34. *Königshain.*
OTTRELITE.	J. Götz. N. J. Beil. Bd. iv. p. 145. *Transvaal, Chem.*
	C. Klement. Min. Mitth. viii. p. 19. *Chem.*
PECTOLITE.	V. Goldschmidt. Ann. Mus. Wien. i. p. 130. *Spec. Grav.*
PERAK.	J. de Morgan. Ann. Min. ix. p. 368. *Min. of.*
PERCYLITE.	M. Websky. Ber. Ak. Berl. 1886, p. 1045. *Chem.*
PLANERITE.	A. Lacroix. Bull. Soc. Min. ix. p. 5. *Opt.*
PLATINUM.	W. Hamilton. N. Z. Inst. xviii. p, 402. *New Zealand.*
PHENACITE.	A. Des Cloizeaux. Am. J. Sc. xxxii. p. 210. *Cryst.;* and Bull. Soc. Min. ix. p. 171.
	A. Purgold. Isis (Ber.), 1885, p. 33. *Oberwallis.*
	G. Seligmann. Verh. Nat. Ver. Rheinl. xxxiv. corr. bl. p. 139. *Wallis.*
PHILLIPSITE.	L. Langemann. N. J. 1886 (2), p. 110. *Mon.*
PHOLERITE.	A. v. Lasaulx. Ber. Nied. Ges. Bonn. 1886, p. 10. *Neurode.*

Digitized by Google

PHOSGENITE.	D. Lovisato. Att. Ac. Linc. Rend. ii. p. 254. *Sardinia.*
PHOSPHORITE.	Bechevel. Ann. Min. x. p. 434. *Chem.*
PIHLITE.	D. Lovisato. Att. Ac. Linc. Rend. ii. p. 259. *Sardinia.*
PISEK.	E. Döll. Verh. Geol. Reichs. 1886, p. 351. *Min. of.*
POLLUX.	A. Purgold. Isis (Ber.), 1885, p. 32. *Elba.*
POLYARSENITE.	L. Igelström. Öfv. Vet. Ak. Förh. 1885, 7, p. 257. *New Min.*
PONTGIBAUD.	F. Gonnard. Bull. Soc. Min. ix. p. 243. *Aurif. Min.*
PREDAZZO.	A. Cathrein. Zs. K. xii. p. 34. *Min. of.*
PREHNITE.	A. Purgold. Isis (Ber.), 1885, p. 34. *Radauthal.*
	F. Schalch. N. J. Beil. Bd. iv. p. 178. *Erzgebirge.*
	D. Lovisato. Att. Ac. Linc. Rend. ii. p. 258. *Sardinia.*
PRISMATINE.	A. Sauer. Zts. Geol. Ges. xxxviii. p. 704. *New. Min.*
PROUSTITE.	E. Rethwisch. N. J. Beil. Bd. iv. p. 31. *Mon.*
PSEUDOBROOKITE.	K. Oebbeke. Zs. K. xi. p. 370. *Mt. Dore, Cryst.*
PTILOLITE.	W. Cross and L. Eakins. Am. J. Sc. xxxii. p. 117. *New. Min.*
PYRARGYRITE.	E. Rethwisch. N. J. Beil. Bd. iv. p. 31. *Mon.*
	M. Schuster. Verh. Geol. Reichs. 1886, p. 68. *Cryst.*; and Zs. K. xii. p. 117.
PYRITES.	L. Brugnatelli. Zs. K. xi. p. 363. *Cryst.*
	E. Smith. Am. J. Sc. xxxi. p. 376. *Limonite pseud. after.*
	J. Meem. Am. J. Sc. xxxii. p. 274. *Limonite pseud. after.*
	A. Jackson. Bull. Cal. Ac. Sc. i. p. 365. *Calaveras Co., Cryst.*
	R. Solly. Min. Mag. vi. p. 203. *Devonshire.*
	Götting. B. H. Ztg. xlv. p. 301. *Styria, Min.*
	Leuze. Jahresh. Ver. Württ. xlii. p. 63. *Quartz pseud. after.*
	E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 15, 21. *Stainz.*
	H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 345. *Chem.*
	E. Döll. Verh. Geol. Reichs. 1886, p. 351. *Pseud. after Tourmaline.*
	A. Wendt. School Min. Q. vii. pp. 154, 218, 301. *Alleghanies.*
	Nentien. Ann. Min. x. p. 462. *Chem.*
PYKOLUSITE.	Opperman. Ann. Min. x. p. 444. *Chem.*
PYROMORPHITE.	P. Jeremejew. Verh. Russ. Min. Ges. xxii. p. 179. *Nertschinsk.*
PYROPHYLLITE.	M. Websky. Zts. Geol. Ges. xxxviii. p. 473. *Georgia.*
PYROSTILPNITE.	A. Streng. N. J. 1886, (1), p. 57. *Chem.*
PYRRHITE.	L. Hubbard. Ber. Nied. Ges. Bonn. 1886, p. 219. *San Miguel.* vid. Azorpyrrhite.
PYRRHO-ARSENITE.	L. Igelström. Bull. Soc. Min. ix. p. 218. *New Min.*
PYRRHOTITE.	H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 345. *Chem.*
	G. Seligmann. Zs. K. xi. p. 343. *Cyclops Is., Cryst.*
	C. Doelter. Min. Mitth. vii. p. 535. *Chem.*
	E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 16, 21. *Stainz.*

Digitized by Google

QUARTZ. G. v. Rath. Festschr. Ver. Natk. Cassel. 1886, p. 98. *Cryst.*
G. v. Rath. Zs. K. xii. p. 453. *Cryst.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 67. *Montevecchio.*
J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
F. Gonnard. C. R. ciii. p. 1036. *Pseud. Puy-de-Dôme.*
B. V. Kolenko. Pogg. xxix. p. 416. *Pyroel.*
O. Tumlirz. Pogg. xxvii. p. 133. *Magnetic.*
V. Goldschmidt. Ann. Mus. Wien. i. p. 130. *Spec. Grav.*
E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 11. *Stainz.*
W. Hidden and A. Des Cloizeaux. Am. J. Sc. xxxii. p. 208. *Cryst.*
J. Danker. N. J. Beil. Bd. iv. p. 266. *Opt.*
O. Tumlirz and H. Luggin. Anz. Ak. Wien. xxiii. p. 93. *Magn.*
Leuze. Jahresh. Ver. Württ. xlii. p. 62. *Pseud. after Calcite, Gypsum, Pyrites, Celestine.*
Leuze. Jahresh. Ver. Württ. xlii. p. 64. *Hyalite pseud. after.*
J. McConnel. Proc. Roy. Soc. xxxix. p. 409. *Opt.*; and Phil. Trans. clxxvii. p. 299.
W. Hidden. School Min. Q. vii. p. 334. *Pseudomorphous.*

RALSTONITE. S. Penfield. Am. J. Sc. xxxii. p. 380. *Chem.*
REDRUTHITE. C. John. Jahrb. Geol. Reichs. xxxvi. p. 345. *Chem.*
RHODONITE. G. Flink. Öfv. Vet. Ak. Förh. 1885, 6, p. 159. *Pajsberg and Langban;* and Zs. K. xi. p. 506.
RITTINGERITE. A. Streng. N. J. 1886 (1), p. 57. *Chem.*
ROSENEGG. Leuze. Jahresh. Ver. Württ. xlii. p. 62. *Min. of.*
RUBY. G. Kunz. Science, vii. p. 399.
RUTILE. O. Mügge. N. J. 1886 (1), p. 147. *Twinning.*
G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 158. *N. Carolina.*
E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 15. *Stainz.*
E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 25. *Modriach.*
M. Websky. Zts. Geol. Ges. xxxviii. p. 473. *Georgia.*

SAINT-NAZAIRE. C. Baret. Bull. Soc. Min. ix. p. 129. *Min. of.*
SALT. J. Lehmann. Zs. K. xi. p. 610. *Contraction-cracks.*
C. Ochsenius. N. J. 1886 (1), p. 177. *Egeln-Stassfurt.*
W. Voigt. N. J. Beil. Bd. iv. p. 228. *Elasticity.*
T. Ward. Trans. Man. Geol. Soc. xviii. p. 396. *Min.*
Leuze. Jahresh. Ver. Württ. xlii. p. 62. *Sandstone pseud. after.*
R. Williams. Chem. News, liv. p. 50. *Chem.*
M. Fack. Schr. Nat. Ver. Schles.-Hols. vi. (2), p. 47. *Schles.-Holstein.*
SAMARSKITE. W. Crookes. Proc. Roy. Soc. xl. p. 502. *Chem.*; and C. R. cii. p. 1464; and Chem. News, liv. p. 13.
SANARKA. A. Arzruni. Ber. Ak. Berl. 1886, p. 1211. *Min. of.*

Digitized by Google

SANIDINE. G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 220. *Niedermendig.*
B. Mierisch. Min. Mitth. viii. p. 176. *Vesuvius.*

SARCOLITE. C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
B. Mierisch. Min. Mitth. viii. p. 152. *Vesuvius.*

SARDINIA. D. Lovisato. Att. Ac. Linc. Rend. ii. p. 254. *Min. of.*

SCAPOLITE, &c. C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
G. Tschermak. Min. Mitth. vii. p. 400. *Chem.*

SCHEELITE. E. Jannetaz and Goguel. Bull. Soc. Min. ix. p. 39. *Pyrenees.*
T. Hiortdahl. Zs. K. xii. p. 411. *Art. Cryst.*

SCHEFFERITE. G. Flink. Öfv. Vet. Ak. Förh. 1885, 10, p. 41. *Langban and Pajsberg;* and Zs. K. xi. p. 487.

SCHUNGITE. A. v. Inostranzeff. N. J. 1886 (1), p. 92. *New Min.*

SCOLECITE. C. Schmidt. Zs. K. xi. p. 587. *Cryst., Pyroel.*
G. Wyrouboff. Bull. Soc. Min. ix. p. 266. *Opt.*

SCOULERITE. A. Lacroix. C. R. cii. p. 645. *Opt. Thomsonite;* and Bull. Soc. Min. ix. p. 80.

SELBECK. Schwarze. Verh. Nat. Ver. Rheinl. xxxiv. corr. bl. p. 75. *Zinc and Lead Ores.*

SEMI-OPAL. R. Solly. Min. Mag. vi. p. 203. *Devonshire.*

SEMSEYITE. L. Sipöcz. Zs. K. xi. p. 216. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 102.

SEVILLE. Calderon. An. Soc. Esp. xv. p. 131. *Min.*

SILVER. G. v. Rath. Ber. Nied. Ges. 1886, p. 281. *Art.*

SILVER ORES. H. Foullon and C. John. Jahrb. Geol. Reichs. xxxvi. p. 341. *Chem.*

SMALTITE. H. Baumhauer. Zs. K. xii. p. 18. *Cryst.*

SMITHSONITE. (?) J. Cooper. Bull. Washb. Lab. i. p. 170. *New Mexico.*

SODALITE. F. Clarke. Am. J. Sc. xxxi. p. 264. *Maine, Chem.*
B. Mierisch. Min. Mitth. viii. p. 163. *Vesuvius.*

SPHENE. E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 15, 21. *Stainz.*
B. Mierisch. Min. Mitth. viii. p. 181. *Vesuvius.*

SPINEL. K. v. Chrustchoff. N. J. 1886 (2), p. 180. *New Variety.*
B. Mierisch. Min. Mitth. viii. p. 182. *Vesuvius.*

SPODUMENE. G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 154. *N. Carolina, Cryst.*
W. Hidden and A. Des Cloizeaux. Am. J. Sc. xxxii. p. 204. *N. Carolina.*

STAFFORDSHIRE. W. Whitaker. Rep. Brit. Ass. 1885, p. 780. *Min. Bibliography.*

STAINZ. E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 3. *Min. of.*

STIBNITE. L. Bombicci. Rendic. Ac. Bol. 1886, p. 43. *Giappone, Cryst.;* and Mem. Ac. Bol. vii. p. 129.
Le Verrier. Ann. Min. x. p. 455. *Chem.*

STRONTIANITE. L. Bourgeois. C. R. ciii. p. 1089. *Art.*

STRUVITE. F. Oettel. Isis (Ber.), 1885, p. 29. *Art.*

SULPHUR. V. Goldschmidt. Ann. Mus. Wien. i. p. 130. *Spec. Grav.*
A. Schrauf. Pogg. xxvii. p. 300. *Therm. Opt.;* and Zs. K. xii. p. 321.

Digitized by Google

SULPHUR.	E. Dana. Am. J. Sc. xxxii. p. 389. *Cryst.*
	A. Purgold. Isis (Ber.), 1885, p. 31. *Perticara.*
	F. Sandberger. N. J. 1886 (1), p. 179. *Chili.*
	T. Haupt. B. H. Ztg. xlv. pp. 313, 325, 333. *Tuscany.*
	G. Lunge. Dingl. J. 259, p. 43. *Saba;* and Chem. Cent. Bl. xvii. p. 334.
	D. Gernez. Ann. Chim. Phys. vii. p. 233. *Art. Cryst.*
SYLVANITE.	L. Sipöcz. Zs. K. xi. p. 210. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 96.
SYLVITE.	R. Brauns. N. J. 1886 (1), p. 224. *Cryst.*
SZABOITE.	K. Oebbeke. Zs. K. xi. p. 373. *Mt. Dore, Cryst.*
TELLURITE.	A. Brezina. Ann. Mus. Wien. i. p. 135. *Cryst.*
TETRAHEDRITE.	G. v. Rath. Ber. Nied. Ges. 1886, p. 190. *Bolivia.*
	De Bechevel. Ann. Min. x. p. 433. *Chem.*
THENARDITE.	Leuze. Jahresh. Ver. Württ. xlii. p. 66. *Calcite pseud. after.*
THULITE.	A. Lacroix. C. R. cii. p. 645. *Opt.;* and Bull. Soc. Min. ix. p. 77.
THURINGITE.	C. Schmidt. Zs. K. xi. p. 599. *Windgällen.*
TOPAZ.	J. Lehmann. Zs. K. xi. p. 611. *Contraction-cracks.*
	W. Ramsay. Zs. K. xii. p. 216. *Refract. Index.*
	H. Bücking. Zs. K. xii. pp. 424, 451. *Mexico, Cryst.*
	F. Feist. Zs. K. xii. p. 434. *Ilmen Mts. Cryst.*
	K. Mack. Pogg. xxviii. p. 153. *Pyroel. Opt.*
	N. Nordenskiold. N. J. 1886 (1), p. 242. *Enclosures.*
	W. Cross. Am. J. Sc. xxxi. p. 432. *Nathrop.*
	A. v. Groddeck. Zts. Geol. Ges. xxxviii. p. 370. *Tasmania.*
TOURMALINE.	A. Schmidt. Zs. K. xii. p. 103. *Zipser Com. Cryst.*
	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 157. *N. Carolina.*
	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 225. *Pierrepont.*
	R. Scharizer. Verh. Geol. Reichs. 1886, p. 109. *Schütenhofen.*
	E. Döll. Ver. Geol. Reichs. 1886, p. 351. *Pyrites pseud. after.*
	J. Woldrich. Verh. Geol. Reichs. 1886, p. 454. *Bohemia.*
	A. Sauer. Zts. Geol. Ges. xxxviii. p. 705. *Waldheim.*
	W. Hidden. Am. J. Sc. xxxii. p. 205. *N. Carolina.*
	H. Schedtler. N. J. Beil. Bd. iv. p. 518. *Elect.*
	E. Riecke. Pogg. xxviii. p. 43. *Pyroel.*
	E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 12. *Stainz.*
TREMOLITE.	B. Mierisch. Min. Mitth. viii. p. 176. *Vesuvius.*
TRIDYMITE.	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 192. *Yellowstone Park.*
	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 256. *Cryst.*
TSCHERMIGITE.	Deichmüller. Isis (Ber.), 1885, p. 33. *Dux.*
TURQUOIS.	F. Clarke and J. Diller. Am. J. Sc. xxxii. p. 211. *New Mexico.*

Digitized by Google

ULLMANNITE.	F. Sandberger. N. J. 1886 (1), p. 90. *Art.*
VANADINITE.	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 34. *Arizona.*
	S. Penfield. Am. J. Sc. xxxii. p. 441. *Arizona and New Mexico.*
	F. Genth and G. v. Rath. Chem. News. liii. p. 218. *Lake Valley.*
	J. Cooper. Bull. Washb. Lab. i. p. 169. *Arizona and New Mexico.*
VARISCITE.	A. Lacroix. C. R. cii. p. 273. *Opt.;* and Bull. Soc. Min. ix. p. 5.
VESUVIUS.	B. Mierisch. Min. Mitth. viii. p. 125. *Min. of.*
WAGNERITE.	A. Ditte. Ann. Chim. Phys. viii. p. 602. *Chem.*
WARWICKITE.	A. Lacroix. C. R. cii. p. 644. *Opt.;* and Bull. Soc. Min. ix. p. 74.
WARWICKSHIRE.	W. Whitaker. Rep. Brit. Ass. 1885, p. 780. *Min. Bibliography.*
WAVELLITE.	A. Lacroix. Bull. Soc. Min. ix. p. 4. *Opt.;* and C. R. cii. p. 273.
WEHRLITE.	L. Sipöcz. Zs. K. xi. p. 212. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 98.
WERNERITE.	C. Rammelsberg. N. J. Beil. Bd. iv. p. 610. *Chem.*
WILLEMITE.	J. Cooper. Bull. Washb. Lab. i. p. 170. *New Mexico.*
WINDGÄLLEN.	C. Schmidt. Zs. K. xi. p. 597. *Min. of.*
WITHAMITE.	A. Lacroix. C. R. cii. p. 644. *Opt.;* and Bull. Soc. Min. ix. p. 75. *Opt.*
WITHERITE.	L. Bourgeois. C. R. ciii. p. 1089. *Art.*
WOLFRAMITE.	L. Sipöcz. Zs. K. xi. p. 211. *Chem.;* and Ber. Chem. Ges. Berl. xix. p. 97.
	G. Seligmann. Zs. K. xi. p. 347. *Cryst.*
WOLLASTONITE.	C. Doelter. N. J. 1886 (1), p. 119. *Art.*
	B. Mierisch. Min. Mitth. viii. p. 173. *Vesuvius.*
	V. Goldschmidt. Ann. Mus. Wien. i. p. 130. *Spec. Grav.*
WORCESTERSHIRE.	W. Whitaker. Rep. Brit. Ass. 1885, p. 780. *Min. Bibliography.*
WULFENITE.	J. Cooper. Bull. Washb. Lab. i. p. 169. *Arizona.*
	F. Sandberger. N. J. 1886 (1), p. 90. *S. America.*
XANTHOLITE.	A. Lacroix. C. R. cii. p. 645. *Opt. Staurolite;* and Bull. Soc. Min. ix. p. 78.
XENOTIME.	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 153. *N. Carolina.*
	W. Hidden and A. Des Cloizeaux. Am. J. Sc. xxxii. p. 206. *N. Carolina.*
	H. Gorceix. C. R. cii. p. 1024. *Minas Geraes.*
YELLOWSTONE PARK.	G. v. Rath. Ber. Nied. Ges. Bonn. 1886, p. 192. *Min. of.*
ZINC.	W. Dawson. Min. Mag. vi. p. xix. *Transvaal.*

Digitized by Google

Zinc.	H. Reusch. Nyt. Mag. xxix. p. 358. *Birkeland.*
Zinc-ore.	Tingry. Ann. Min. x. p. 465. *Chem.*
	Sergère. Ann. Min. x. p. 476. *Chem.*
	Poncelet. Ann. Min. x. p. 479. *Chem.*
Zincite.	E. Dana. Am. J. Sc. xxxii. p. 388. *Cryst.*; and Zs. K. xii. p. 459.
Zircon.	A. Gehmacher. Zs. K. xii. p. 50. *Pfitsch, Cryst.*
	K. de Chrustchoff. Min. Mitth. vii. p. 423. *Microscop.*
	L. Michel. Bull. Soc. Min. ix. p. 215. *Opt. Colour.*
	L. Hubbard. Ber. Nied. Ges. Bonn. 1886, p. 218. *Laacher See.*
	E. Hussak. Mitth. Nat. Ver. Steier. xxii. p. 13. *Stainz.*
Zoisite.	E. Hussak. Mitth. Nat. Ver. Steier. xxii. pp. 13, 21. *Stainz.*

1885 *(continued)*.

Allactite.	J. Krenner. Ber. Ung. iii. p. 214. *Opt.*
Amazon-stone.	E. Erdmann. Zs. K. x. p. 493. *Colour.*
Anglesite.	Q. Sella. Att. Ac. Linc. Mem. ii. p. 199. *Cryst.* (*republ.*).
Anorthite.	G. Struever. Att. Ac. Linc. Mem. i. p. 12. *L. Bracciano.*
Apatite.	G. Struever. Att. Ac. Linc. Mem. i. p. 13. *L. Bracciano.*
	V. v. Zepharovich. Lotos. xxxiv. p. 85. *Turquois pseud. after.*
Aragonite.	G. Dewalque. Ann. Soc. Geol. Belg. Bull. xii. p. 56. *Sarola.*
Aranyer Berg.	A. Koch. Ber. Ung. iii. p. 44. *Min. of.*
Arizona.	G. Kunz. Ann. New York Ac. iii. p. 275. *Min. of.*
Aurichalcite.	G. Kunz. Ann. New York Ac. iii. p. 278. *Arizona.*
Barytes.	F. Sansoni. Rend. Ac. Bol. 1885, p. 52. *Vernasca.*
Blende.	L. Sipöcz. Ber. Ung. iii. p. 30. *Kapnik, Nagyag, &c.*
Bournonite.	L. Sipöcz. Ber. Ung. iii. p. 33. *Nagyag.*
Calcite.	G. Struever. Att. Ac. Linc. Mem. i. p. 13. *L. Bracciano.*
Carinthia.	A. Brunlechner. Jahrb. L. Mus. Kärnt. xvii. p. 227. *Min. of.*
Celestine.	F. Koch. Ber. Ung. iii. p. 227. *Siebenburgen, Chem.*
Cerussite.	V. v. Zepharovich. Lotos. xxxiv. p. 81. *Littai.*
	G. Kunz. Ann. New York, Ac. iii. p. 278. *Arizona.*
Cerargyrite.	J. Cooper. Bull. Washb. Lab. i. p. 30. *Colorado.*
Chalybite.	A. Brunlechner. Jahrb. L. Mus. Kärnt. xvii. p. 229. *Chem.*
Chessylite.	G. Kunz. Ann. New York Ac. iii. p. 276. *Arizona.*
Chromite.	G. Ulrich. N. Z. J. Sc. ii. p. 310. *N. Zealand.*
Chrysocolla.	G. Kunz. Ann. New York Ac. iii. p. 276. *Arizona.*
Cobalt-ores.	J. Readman. Proc. Roy. Soc. Ed. xiii. p. 65. *New Caledonia.*
Colemanite.	A. Jackson. Bull. Cal. Ac. Sc. ii. p. 3. *Cryst.*
	J. Evans. Bull. Cal. Ac. Sc. ii. p. 37. *Chem.*
Copper.	Jentzsch. Schr. Phys. Ges. Königs. (Ber.), xxv. p. 45. *Min.*
Crystallography.	G. Cesaro. Ann. Soc. Geol. Belg. Mem. xii. p. 82. *Math.*
	Q. Sella. Att. Ac. Linc. Mem. ii. pp. 45, 210. *Math* (*republ.*).

Digitized by Google

CUPRITE.	G. Kunz. Ann. New York, Ac. iii. p. 277. *Arizona.*
DECHENITE.	J. Cooper. Bull. Washb. Lab. i. p. 30. *New Mexico.*
DELVAUXITE.	G. Cesaro. Ann. Soc. Geol. Belg. Mem. xii. p. 192. *Pseud. after Gypsum.*
DESCLOIZITE.	J. Cooper. Bull. Washb. Lab. i. p. 30. *New Mexico.*
DESTINEZITE.	G. Cesaro. Ann. Soc. Geol. Belg. Mem. xii. p. 173. *Chem. Cryst.*
DIOPTASE.	G. Kunz. Ann. New York, Ac. iii. p. 277. *Arizona.*
DOLOMITE, &c.	L. Bombicci. Rend. Acc. Bol. 1885, p. 51. *Cryst.*
EPIDOTE.	G. Ulrich. N. Z. J. Sc. ii. p. 312. *N. Zealand.*
FUCHSITE.	G. Ulrich. N. Z. J. Sc. ii. p. 309. *N. Zealand.*
GALENA.	K. Jahn. Ber. Ung. iii. p. 234. *Radna, Chem.*
GARNET.	G. Struever. Att. Ac. Linc. Mem. i. p. 9. *L. Bracciano.*
GOLD.	R. Jack. Dingl. J. 258, p. 45. *Mt. Morgan.*
GYPSUM.	F. Cragin. Bull. Washb. Lab. i. p. 88. *Kansas.*
	G. Cesaro. Ann. Soc. Geol. Belg. Mem. xii. p. 192. *Delvauxite pseud. after.*
HAEMATITE.	K. Jahn and M. Hassak. Ber. Ung. iii. p. 232. *Chem.*
HAUYNE.	G. Struever. Att. Ac. Linc. Mem. i. p. 11. *L. Bracciano.*
HORNBLENDE.	G. Struever. Att. Ac. Linc. Mem. i. p. 9. *L. Bracciano.*
HUMBOLDTILITE.	G. Struever. Att. Ac. Linc. Mem. i. p. 11. *L. Bracciano.*
	A. Firket. Ann. Soc. Geol. Belg. Bull. xii. p. 194. *Art.*
IDOCRASE.	G. Struever. Att. Ac. Linc. Mem. i. p. 10. *L. Bracciano.*
ILMENITE.	G. Ulrich. N. Z. J. Sc. ii. p. 311. *N. Zealand.*
KRENNERITE.	L. Sipöcz. Ber. Ung. iii. p. 23. *Nagyag.*
L. BRACCIANO.	G. Struever. Att. Ac. Linc. Mem. i. p. 3. *Min. of;* and Rend. p. 173.
LEUCITE.	G. Struever. Att. Ac. Linc. Mem. i. p. 12. *L. Bracciano.*
LIMONITE.	G. Struever. Att. Ac. Linc. Mem. i. p. 8. *L. Bracciano.*
MAGNETITE.	G. Struever. Att. Ac. Linc. Mem. i. p. 8. *L. Bracciano.*
MALACHITE.	W. Spring. Ann. Soc. Geol. Belg. Bull. xii. p. 191. *Art.*
	G. Kunz. Ann. New York Ac. iii. p. 275. *Arizona.*
MENEGHINITE.	Q. Sella. Att. Ac. Linc. Mem. ii. p. 197. *Cryst. (republ.).*
MICA.	G. Struever. Att. Ac. Linc. Mem. i. p. 11. *L. Bracciano.*
NAGYAGITE.	L. Sipöcz. Ber. Ung. iii. p. 24. *Nagyag.*
NEPHELITE.	G. Struever. Att. Ac. Linc. Mem. i. p. 11. *L. Bracciano.*
NEW CALEDONIA.	J. Readman. Proc. Roy. Soc. Ed. xiii. p. 65. *Ores of.*
NEW MEXICO.	H. Furman. School Min. Q. vi. p. 138. *Ores of.*
	J. Cooper. Bull. Washb. Lab. i. p. 30. *Min. of.*

Digitized by Google

NEW ZEALAND.	G. Ulrich. N. Z. J. Sc. ii. p. 306. *Min. of.*
NICKEL ORE.	L. Sipöcz. Ber. Ung. iii. pp. 27, 29. *Chem.*
	J. Beadman. Proc. Roy. Soc. Ed. xiii. p. 65. *New Caledonia.*
OPEN.	F. Koch. Ber. Ung. iii. p. 240. *Min. Chem.*
ORTHOCLASE.	G. Ulrich. N. Z. J. Sc. ii. p. 314. *New Zealand.*
	G. Struever. Att. Ac. Linc. Mem. i. p. 13. *L. Bracciano.*
	J. Cooper. Bull. Washb. Lab. i. p. 29. *Colorado.*
OSNABRÜCK.	Renesse. Jahresb. Nat. Ver. Osnabr. vi. p. 46. *Min.*
PHOSPHORITE.	E. Delvaux. Ann. Soc. Geol. Belg. Buil. xii. p. 39. *Belgium*
	M. Lohest. Ann. Soc. Geol. Belg. Mem. xii. p. 41. *Hesbaye.*
	M. Lohest. Ann. Soc. Geol. Belg. Bull. xii. p. 74. *Alleur.*
	G. Dewalque. Ann. Soc. Geol. Belg. Bull. xii. p. 93.
PROCHLORITE.	G. Ulrich. N. Z. J. Sc. ii. p. 310. *N. Zealand.*
PSEUDOBROOKITE.	A. Koch. Ber. Ung. iii. p. 44. *Aranyer Berg.*
PYRITES.	K. Jahn. Ber. Ung. iii. p. 234. *Radna, Chem.*
	Q. Sella. Att. Ac. Linc. Mem. ii. p. 213. *Cryst.* (*republ.*).
PYROMORPHITE.	J. Cooper. Bull. Washb. Lab. i. p. 30. *Arizona and New Mexico.*
PYROXENE.	G. Struever. Att. Ac. Linc. Mem. i. p. 9. *L. Bracciano.*
QUARTZ.	G. Dewalque. Ann. Soc. Geol. Belg. Bull. xii. p. 56. *Sarolay.*
	W. Hankel. Pogg. xxvi. p. 150. *Thermoel.*
	S. Meunier. La Nat. xiii. p. 240. *Enhydros, Nemours.*
RUTILE.	G. Ulrich. N. Z. J. Sc. ii. p. 310. *N. Zealand.*
SALT.	Tournaire. Ann. Min. vii. p. 356. *Compression.*
SARCOLITE.	G. Struever. Att. Ac. Linc. Mem. i. p. 11. *L. Bracciano.*
SARDINIA.	Q. Sella. Att. Ac. Linc. Mem. ii. p. 53. *Min. of* (*republ.*).
SAVITE.	Q. Sella. Att. Ac. Linc. Mem. ii. p. 145. (*Republ.*)
SEMSEYITE.	L. Sipöcz. Ber. Ung. iii. p. 30. *Felsobanya.*
SPHENE.	G. Struever. Att. Ac. Linc. Mem. i. p. 13. *L. Bracciano.*
	G. Ulrich. N. Z. J. Sc. ii. p. 311. *N. Zealand.*
SPINEL.	G. Struever. Att. Ac. Linc. Mem. i. p. 8. *L. Bracciano.*
STOLZITE.	J. Cooper. Bull. Washb. Lab. i. p. 30. *New Mexico.*
SYLVANITE.	L. Sipöcz. Ber. Ung. iii. p. 23. *Offenbanya.*
SZABOITE.	A. Koch. Ber. Ung. iii. p. 44. *Aranyer Berg.*
	F. Koch. Ber. Ung. iii. p. 236. *Chem.*
TOPAZ.	G. Cesaro. Ann. Soc. Geol. Belg. Mem. xii. p. 116. *Cryst.*
TOURMALINE.	M. Lohest. Ann. Soc. Geol. Belg. Bull. xii. pp. 36, 95. *Belgium.*
	E. Riecke. Nachr. Ges. Wiss. Gött. 1885, p. 405. *Pyroel.*
TURQUOIS.	V. v. Zepharovich. Lotos. xxxiv. p. 85. *Pseud. after Apatite.*
URALITE.	Kloos. Deutsch. Naturf. Tagebl. lviii. p. 90.

Digitized by Google

UVAROVITE.	G. Ulrich. N. Z. J. Sc. ii. p. 308. *N. Zealand.*
VANADINITE.	J. Cooper. Bull. Washb. Lab. i. p. 30. *New Mexico, &c.*
WEHRLITE.	L. Sipöcz. Ber. Ung. iii. p. 25. *Deutsch-Tilsen.*
WOLFRAMITE.	L. Sipöcz. Ber. Ung. iii. p. 25. *Felsobanya.*
WOLLASTONITE.	G. Struever. Att. Ac. Linc. Mem. i. p. 8. *L. Bracciano.*
WULFENITE.	J. Cooper. Bull. Washb. Lab. i. p. 30. *New Mexico.*
ZINCITE.	A. Firket. Ann. Soc. Geol. Belg. Bull. xii. p. 192. *Art.*
ZYGADITE.	J. Krenner. Ber. Ung. iii. p. 217. *Cryst. Chem. &c.*

1884 *(continued).*

ALBITE.	Kloos. Deutsch. Naturf. Ber. lvi. p. 90.
CALCITE.	F. Sansoni. Att. Ac. Linc. Mem. xix. p. 45. *Andreasberg, Cryst.*
CARINTHIA.	R. Canaval. Jahrb. L. Mus. Kärnt. xvi. p. 185. *Copper Ores.*
COLEMANITE.	J. Evans. Bull. Cal. Ac. Sc. i. p. 57. *New Min.*
COLUMBITE.	G. Struever. Att. Ac. Linc. Rend. i. p. 8. *Craveggia.*
CRYSTALS.	B. Minnigerode. Nachr. Ges. Wiss. Gött. 1884, pp. 195, 374, 488. *Elasticity.*
	W. Voigt. Nachr. Ges. Wiss. Gött. 1884, p. 337. *Light absorption.*
DIOPSIDE.	La Valle. Att. Ac. Linc. Mem. xix. p. 149. *Cryst.*
DUBLIN.	W. O'Neill. Sci. Goss. xx. pp. 77, 219. *Min. qf.*
GALENA.	Taylor. Sci. Goss. xx. p. 141. *Paisley.*
HANKSITE.	W. Hidden. Ann. New York, Ac. iii. p. 238. *New Min.*
LABRADORITE.	Kloos. Deutsch. Naturf. Ber. lvi. p. 90. *Altered.*
LEUCITE.	C. Klein. Nachr. Ges. Wiss. Gött. 1884, pp. 129, 422. *Opt. Therm.*
NEW MINERALS.	vid. Hanksite.

1883 *(continued).*

ARAGONITE.	C. Klein. Nachr. Ges. Wiss. Gött. 1883, p. 341. *Altered, Opt.*
ARGENTITE.	Ponzi. Att. Ac. Linc. Trans. vii. p. 188. *Tolfa.*
CINNABAR.	Ponzi. Att. Ac. Linc. Trans. vii. p. 188. *Tolfa.*
SPHENE.	A. Cossa. Att. Ac. Linc. Trans. vii. p. 34. *Cont. Yttrium.*
ULLMANNITE.	C. Klein. Nachr. Ges. Wiss. Gött. 1883, p. 25. *Cryst. Chem.*

Digitized by Google

LIST OF ABBREVIATIONS USED IN INDEX.

See also Vol. vi. pp. 142, 187, 232 ; Vol. vii. p. 111.

ABH. BÖHM GES.	Abhandlungen der mathematisch-naturwissenschaftlichen Classe der k. böhmischen Gesellschaft der Wissenschaften. Prag.
ABH. NAT. GES. HALLE.	Abhandlungen der naturforschenden Gessellschaft zu Halle. Halle.
ANN. MUS. WIEN.	Annalen der k. k. naturhistorischen Hofmuseums. Wien.
ANN. SOC. BRUX.	Annales de la Société Scientifique de Bruxelles. Bruxelles.
ANN. SOC. GEOL. BELG.	Annales de la Société Géologique de Belgique (Bull. & Mem.). Liège.
ARCH. MATH. NAT.	Archiv for Mathematik og Naturvidenskab. Kristiania.
BER. NAT. GES. FREIB.	Berichte der naturforschenden Gesellschaft zu Freiburg i. Baden. Freiburg.
BULL. CAL. AC. SC.	Bulletin of the California Academy of Sciences. San Francisco.
BULL. PHIL. SOC. WASH.	Bulletin of the Philosophical Society of Washington. Washingt n.
BULL. SCI. NORD.	Bulletin Scientifique du Departement du Nord. Paris.
BULL. WASHB. LAB.	Bulletin of the Washburn Laboratory of Natural History. Topeka, Kansas.
DEUTSCH. NATURF.	Versammlung deutscher Naturforscher und Aerzte. (Tageblatt u. Bericht).
JAARB. AK. AMST.	Jaarboek van de Koninklijke Akademie van Wetenschappen. Amsterdam.
JAHRESB. NAT. VER. OSNABR.	Jahresbericht des naturwissenschaftlichen Vereins zu Osnabrück. Osnabrück.
KOSMOS.	Kosmos. Kopernik.
LA NAT.	La Nature. Paris.
MEM. AC. TOUL.	Mémoires de l'Académie des Sciences, Inscriptions, et Belles-Lettres de Toulouse. Toulouse.
NACHR. GES. WISS. GÖTT.	Nachrichten von der k. Gesellschaft der Wissenschaften und der Georg-Augusts-Universitäts zu Göttingen. Göttingen.
N. Z. J. SC.	The New Zealand Journal of Science. Dunedin.
PUBL. INST. LUX.	Publications de l'Institut Royal Grand Ducal de Luxembourg. Luxembourg.
SCI. GOSS.	Hardwicke's Science Gossip. London.
SCHOOL MIN. Q.	The School of Mines Quarterly. New York.
VERH. SIEB. VER.	Verhandlungen und Mittheilungen des Siebenbürgischen Vereins für Naturwissenschaften. Hermannstadt.

Digitized by Google

INDEX TO VOL. VII.

	PAGE
Council Meeting, December 8th, 1885	i.
Council Meeting, January 26th, 1886	i.
Council Meeting, May 10th, 1886	i.
General Meeting, December 8th, 1885	ii.
General Meeting, May 21st, 1886	ii.
Receipts and Payments	v. xiv.
Donations to the Library	vi. xv. xvi.
Council Meeting, June 22nd, 1886	viii.
Council Meeting, October 26th, 1886	viii.
General Meeting, June 22nd, 1886	viii.
Anniversary Meeting, October 26th, 1886	ix.
Annual Report for 1885-86	ix.
Council Meeting, January 11th, 1887	xi.
Council Meeting, April 4th, 1887	xi.
General Meeting, January 11th, 1887	xi.
General Meeting, May 10th, 1887	xiii.
Council Meeting, October 25th, 1887	xvii.
Anniversary Meeting, October 25th, 1887	xvii.
Annual Report for 1886–87	xvii.

Digitized by Google

Collins, J. H., on Clays 205
*Colorado, Kobellite from 117
*———, Rhyolite of 115
Copper-ores of Chili 19
*Cordierite 44
Cornwall, Apatite from 141
———, Francolite from 57
———, Granite of 161
———, New Mineral from 65
Creatine 189
*Cross, W., on Topaz and Garnet in Lithophyses of Rhyolite .. 115
*———, and L. G. Eakins, on Ptilolite 115
Crystals, Optical Anomalies of 46, 177
———, Solution-planes of 81
Cuprite 187

*Dana, on Brookite (Arkansite) 115
*Descloizite 165
Diatomaceous Deposits in Skye 35
Diatomite 30
*Diopside 48
*Diorite and Diorite-schist 170, 171
*Doelter, C., on Optical Characters of Pyroxene 117
Dufrenite 65-70

Eakins, L. G. *See* Cross, W.
Eclogite 1
*Ejected Blocks of Laacher See District 227
*Elæolite-syenites 231
Eruptive Rocks from Armenia, &c. 155
*————————, Glassy Base of 218

*Fairfieldite 115
*Fayalite 116
Felspar from Kilima-njaro 131
Fletcher, L., on Meteoric Iron 121, 179, 183
———, on Cuprite, &c. from buried Coins 187
———, on Crystalline Form of Creatine 189
———, and H. A. Miers, on Felspar from Kilima-njaro .. 131
Flight, Dr., on Apatite 57, 58, 60
*Flink, G., on Pyroxene Minerals of Sweden 48
*Fouqué, M., on Granulite-nodules of Ghistorrai 168
Francolite 57, 60, 164
Furuhjelm, the late E. H. 216

Galenas of Chili 19

The Asterisk denotes an *Abstract*.

Digitized by Google

Garnet 9, 44, 115, 237
Gastaldite 6
Genoa, Glaucophane Rock near 5
*Germanium 48
Gilbertite 79
*Glass-inclusions in Granite 169
*Glassy Base of Eruptive Rocks 218
Glaucophane 150-154, 191
Glaucophane-amphibolite 151
Glaucophane-eclogite 1
Gloucestershire, Celestine from 142
*Gneiss of Africa 170
Gnomonic Projection 145
Gold-ores of Chili 18
*Göthite 114
*Graeff, Von F. F., on Elæolite-syenites of Brazil 231
*Granite of Africa 170
———, containing Andalusite 161
*———, Glass-inclusions in 169
*"Granite à Amphibole" of Vaugneray 165
*Granulite-nodules 168
Greenockite 133
*Grossarl, Chloritoidschiefer of 174
Gylling, H., on Eruptive Rocks from Armenia, &c. 155
———, on the late E. H. Furuhjelm 216

Hampton, J. H., on Cassiterite from Straits Settlements 71
Heddle, Dr., on Agalmatolite 24, 25, 28
———, on Calcite from Sutherland 138
———, on Greenockite 133
*Hintze, Dr. C., on Arsenolamprite 47
*———, on Celestine from Lüneberg 177
*Homburg, Struvite from 114
Honeyman, Rev. D., on "Albertites" 77
*Hubbard, Von L. L., on Ejected Blocks of the Laacher See District .. 227
Hydro-carbon Compounds, Nomenclature of 13

*Iddings, J. P., on Lythophysæ, &c. 175
Idocrase 9
Ile de Groix, Glaucophane-rock from 150
*Iron-ores of Lake Superior Region 236
*Irving, R. D., on Iron-ores, &c., of Lake Superior Region .. 236

*Jannasch, P., on Water in Clinochlore 114
Japan, Glaucophane of 153
Judd, Prof. J. W., on Leucite in Australia 194
——, on Schillerization 81

*Kalkowsky, E., on Struvite from Homburg 114

Digitized by Google

Kaolin and Kaolinite 75, 76, 79, 205
*Kars, Liparite, Augite-andesite, and Obsidian from .. 155, 157, 159
*Kasbek, Albite from 165
*Keller, H. F. and H. A., on Kobellite 117
*Kenngott, A., on Priceite, Colemanite, and Pandermite .. 115
Kerr, J. F., on Metallic Ores of Chili 18
*Kersantite 166
*Kerzanton 166
Kilima-njaro, Felspar from 131
———, Orthoclase from 10
Kinch, E., on Plattnerite 63
———, Butler, and Miers, on a New Mineral from Cornwall .. 65
*Kobellite 117
Koto, Prof. B., on Glaucophane in Japan 153
Kraurite (Dufrenite) 67-70
*Kroustchoff, K. de, Artificial Production of Quartz, &c. by .. 236

*Laacher See District, Ejected Blocks of 227
Lacroix, M. A. *See* Michel-Levy, M. A.
*Lagorio, Dr. A., on Glassy Base of Eruptive Rocks 218
*Lake Superior District, Iron-ores of 236
*Lavas, Acid, Lamination of 175
Lead in Calcites 143
Leadhills District, "Plumbo-calcite" of 143
Leucite 194
*Leuco-manganite 115
Levant Mine, Cornwall, Francolite from 57
Lewis, W. J., on Idocrase, &c. from Zermatt 9
Limonite 72
*Liparite 155, 156
*———, Cordierite in 44
*Lithophysæ, Nature and Origin of 175
Louis, H., on Bismutite in the Transvaal 139
*Ludwigite 43
*Lüneberg, Celestine from 177

Macadam, W. I., on Agalmatolite 28, 29, 74
———, on Bruiachite 42
———, on China Clay 75, 76
———, on Diatomaceous Deposits 35
———, on Diatomite 30
———, on Limonite 72
———, on Talc in Paper-making 75
*Magma, Crystallisation of, &c. 169, 218
Malay Peninsula, Cassiterite of 71
*Mallard, M. E., on Optical Anomalies of Crystals 46
*———, on Twin-crystals 44

The Asterisk denotes an *Abstract*.

Digitized by Google

Masgerth, Augite-andesite from 158
Metallic Ores of Chili 18
Meteoric Iron of Arabia 179
——— of Virginia 183
——— of Western Australia 121
*Methylene Iodide in Mineralogy 177
*Mica-schist 171
*Micas, Boric Acid in 115
*Michel-Levy, M. A., and M. A. Lacroix, on Granite of Vaugneray 165
Midlothian, Barytes from 49
Miers, H. A., on Gnomonic Projection 145
———, Index to Mineralogical Papers, 1885, by 93-113
———, „ „ „ 1886, „ 238-260
———, on New Mineral from Cornwall 70
———, on Orthoclase and Adularia 10
———, and G. T. Prior, on Proustite containing Antimony .. 196
See also under Fletcher *and* Kinch.
Mineral-resin 215
Mineralogical Papers, Index to 93-113, 238-260
*Mineralogy, Methylene Iodide in 177
Minerals found near Zermatt 9
———, New 47, 65

New Brunswick, Albertite of 77
*North Carolina, Quartz Crystal from 43
*Nosean-bearing Rocks 227

Obituary:—E. H. Furuhjelm 216
Obsidian 159, 175
*Optical Anomalies of Crystals 46, 177
*——— Characters of Pyroxene 117
Ores of Chili 18
Orthoclase 10, 79
Ozokerite 16

*Palla, E., on Göthite 114
*Pandermite 115
Paper-making, Talc used in 75
*Pegmatite 115
Peridotites of the Cortlandt Series 81
Pinite 28, 44
Plattnerite 63
Plumbo-calcite 143
Portugal, Anglesite from 61
*Priceite 115
Prior, G. T. *See* Miers.
Proustite 44, 196
*Ptilolite 115

Digitized by Google

Pyrargyrite 20, 44
Pyroxene 48, 117

*Quartz, Artificial Production of 236

Rade de Brest, Kerzanton of the 166
*Rath, Vom, on Andesite from Sardinia 43
*——, on a Quartz Crystal from North Carolina 43
Red Garnet 9
—— Silver 43, 145
*Renard, M. A., on Ludwigite 43
Resin, Mineral 215
*Rethwisch, E., on Red Silver 43
*Reusch's Artificial Twins of Calcite 45
Rhyolite 115
Robinson, H., on Apatite 58, 59
Rock-magmas 169, 218
Roman Coins, Crystals from 187
Ross-shire, Agalmatolite of 74
——————, Limonite of 72
Rutile-needles in Clays 201

Saint Austell, Schorlaceous Rocks near 79
*Sandberger, F., on Boric Acid in Micas, &c. 115
Sands, Zircon, &c. in 201
*Sardinia, Andesite from 43
*Scacchi, E., on Cordierite (Pinite) 44
*——, on Garnet 44
Schefferite 48
Schillerization, Theory of 81-92
Schorlaceous Rocks from near St. Austell 79
*Schuster, Dr. Max, on Albite and Braunite 165
Scotland, Albertite of 77
Semmons, on Anglesite .. .. viii.
Shale Oil 13
Silver, Red 43, 145
Silver-ore of Chili 18
Skye, Diatomaceous Deposits in 35
Solly, R. H., on Anglesite from Portugal 61
——, on Apatite from Cornwall 141
——, on Celestine from Gloucestershire 142
——, on Francolite from Cornwall 57
Straits Settlements, Cassiterite of 71
Struvite 114
Sutherland, Calcite from 138

The Asterisk denotes an *Abstract.*

Digitized by Google

*Sweden, Pyroxene Minerals of 48
Switzerland, Adularia from 10

Talc used in Paper-making 75
Taylor, A., on Hydro-carbon Compounds 13
Teall, J. J. H., on Cheesewring Quarry Granite 161
———, on Rutile-needles in Clays 201
Thomson, J. S., on Lead in Calcites 143
————, on a Mineral Resin 215
Tin from Straits Settlements 71
*Topaz 115
Torbanite 13
Transvaal, Bismutite of 139
Trechmann, C. O., on Barytes from Midlothian 49
*Tridymite, Artificial Production of 236
*Tuscany, Cordierite of 44
*Twin-crystals 44, 237
Twinning, Secondary 81
*Twins of Calcite, artificial 45

Val d' Aoste, Glaucophane-eclogite from 1
*Vaugneray, Granite of 165
Vaugnerite 165
Virginia, Meteoric Iron of 183

Wallace, T. D., Bruiachite found by 42
Williams, G. H., on Peridotites of the Cortlandt Series .. 81
Wilson, J. S. G., on Diatomaceous Deposits in Skye .. 35
*Wulf, H., on Petrography of the Hererolandes, S.W. Africa .. 170

Yellowstone Region Lavas 175

Zermatt, Minerals found near 9
Zircon, &c. in Clays and Sands 201

Printed by Williams and Strahan, 7 Lawrence Lane, Cheapside.

Digitized by Google

Digitized by Google

Jahrbuch der K. K. Geologischen Reichsanstalt, Band XXXVI., Heft. I.; and Verhandlungen der K. K. Geolog. Reichsanstalt, Nos. 16 to 18, 1885, and Nos. 1 to 7, 1886. Presented by the Institute.

Mineralogische und petrographische Mittheilungen. Herausgegeben von G. Tschermak. Neue Folge, Band VII. Hefte IV. and V. Presented by the Editor.

Annales de la Société Géologique de Belgique. Tome douzième. Presented by the Society.

Bollettino del R. Comitato Geologica d' Italia. Nos. 11 and 12, 1885, and Nos. 1 to 4, 1886. Presented by the Survey.

Atti della Società Toscana di Scienze Naturali, Memorie, Vol. VII.; Processi Verbali, Vol. V. Presented by the Society.

Annales de la Sociedad Cientifica Argentina. Tomo XXI., Parts 1 and 2; and Examen de la Propuesta y Proyecto del Puerto del Sr. D. Eduardo Madero. Por Luis A. Huergo. Parts 1 and 2; Buenos Ayres, 1886. Presented by the Scientific Society of the Argentine Republic.

Digitized by Google

EXCERPT MINUTES OF COUNCIL MEETING

Held at the Museum, Jermyn Street, June 22nd, 1886.

The following Member was elected—

ANDREW TAYLOR, F.C.S., 11 Lutton Place, Edinburgh.

EXCERPT MINUTES OF COUNCIL MEETING

Held at the Museum, Jermyn Street, October 26th, 1886.

The Draft Report for the year 1885-6 was adopted for submission to the Society.

The following days were fixed for the Meetings of the Society during the coming session:—

January 11th, 1887.
May 10th, 1887,
October 25th, 1887, Anniversary.
The date of the Scotch Meeting to be announced hereafter.

GENERAL MEETING.

Held at the Museum, Jermyn Street, June 22nd, 1886.

L. FLETCHER, M.A., F.G.S., President, in the Chair.

The following papers were read:—

"On Barytes from Addiewell, West Calder, N.B." By C. O. Trechmann, Ph.D. (p. 49.)

"On Plattnerite." By Prof. E. Kinch, F.I.C. (p. 63.)

"On Dufrenite." By F. H. Butler, M.A., A.R.S.M. (p. 65.)

"On Apatite from Cornwall." By R. H. Solly, F.G.S. (p. 57.)

"On Anglesite from Portugal." By R. H. Solly, F.G.S. (p. 61.) Mr. Semmons remarked, that in the large heaps of pyrites from the San Domingo Mine which he had seen near Liverpool, he had noticed small strings of Galena from $\frac{1}{16}$th to $\frac{1}{4}$ inch wide. The crystals of Anglesite, which had been frequently met with in this pyrites, were generally very small and of a light yellow colour, sometimes being quite transparent. He congratulated Mr. Solly on the fine crystal exhibited, it being, compared with those he had seen, as a leviathian among pigmies. It might be of interest to remark that one of these pyrites heaps which had been exposed for some years at Garston in the open air had, by the formation of copper and lime sulphates, become as hard as mortar, so that explosives had to be used to break it up.

Mr. Rudler exhibited some specimens of "Anglesite" from the Ludlam Collection, illustrative of Mr. Solly's paper.

Mr. Semmons exhibited some crystals of Aragonite from Colorado and the Indian Territory. The interest of the specimens was increased by

Digitized by Google

their almost precise similarity of appearance though raised from localities at least 300 miles apart. The crystals showed the close relations that exist between the lead and lime carbonates.

Mr. Simpson (visitor) exhibited a very large crystal of blue topaz, rolled, found in a tin drift in Tasmania.

Mr. C. J. Woodward, F.G.S., exhibited a semicircular protractor for use in class lectures.

The President exhibited specimens of crystallised "Colemanite;" crystallised "Argyrodite," containing the new metal "Germanium;" Polysynthetic "Calcite."

ANNIVERSARY MEETING.

Held at the Museum, Jermyn Street, October 26th, 1886.

L. Fletcher, M.A., F.G.S., President, in the Chair.

The following Report of Council was read and adopted:—

The Balance Sheet of the Society for the year 1884-5, which appeared in No. 32 of the Journal, showed that the finances of the Society continue in a satisfactory condition. The excess of Assets over Liabilities amounted to £241 4s. 3d., being an increase of £25 11s. 11d. during the year.

The number of members elected since the last Anniversary has been ten, while the resignations have been twelve in number. In addition, four names have been removed from the list for non-payment of subscriptions during three years. The Council have to notice with extreme regret that among the resignations, owing to continued ill health, the name of Mr. R. P. Greg, their former Treasurer, appears. It will be remembered that Mr. Greg was joint author (with Mr. W. G. Lettsom) of the "Manual of British Mineralogy," which still remains our best authority for British Mineral Species.

Three Meetings have taken place since the last Anniversary. Those in December 1885 and June 1886 were held in the Museum of Economic Geology, by kind permission of the Director-General of the Geological Survey.

The third was held at St. Andrew's, in May 1886, and was equally successful with the Scotch Meetings of the previous two years.

Two Parts of the Journal have appeared during the year, and the Council have again to remind the Society that the number of

Digitized by Google

members who contribute to its Proceedings is very limited. It is only by the active co-operation of the members that the value of the Journal as a scientific publication can be maintained.

Messrs. Miers and Solly were appointed Scrutineers, and reported that the following had been elected Officers and Council for the ensuing year:—

President.	L. Fletcher, M.A., F.G.S.
Vice-Presidents.	Rev. S. Haughton, M.D., F.R.S.
	W. H. Hudleston, M.A., F.R.S.
Council.	Prof. J. W. Judd, F.R.S.
	Prof. E. Kinch, F.I.C., F.C.S.
	Prof. W. Ivison Macadam, F.I.C., F.C.S.
	J. H. Teall, F.G.S.
Treasurer.	Rev. Professor T. G. Bonney, D.Sc., F.R.S.
General Secretary.	R. H. Scott, M.A., F.R.S.
Foreign Secretary.	T. Davies, F.G.S.
Auditors.	B. Kitto, F.G.S.
	F. W. Rudler, F.G.S.

On the motion of Mr. Davies, seconded by Mr. Scott, it was resol

"That the thanks of the Society be voted to Dr. A. Geikie for his kind permission to use the Theatre for its meetings."

The following papers were then read :—

"On the Cassiterite of the Straits Settlements." By J. H. Hampton. (p. 71.)

"On the Analysis of a Sample of Talc used in Paper making." By Prof. W. I. Macadam, F.I.C., F.C.S. (p. 75.)

"On the Analyses of Cornish China Clays (Kaolinite)." (p. 76.)

"On the Occurrence of considerable Deposits of Limonite in North-west Ross-shire." (p. 72.)

"Further Note on Agalmatolite in Gairloch Parish, Ross-shire." (p. 74.)

"Short List of Minerals obtained in Gairloch Parish, North-west, Ross-shire." (p. 73.)

Professor Macadam also submitted a provisional list of minerals occurring in Gairloch Parish, Ross-shire.

"Note on the identification of the Scotch and New Brunswick Albertite." By Rev. Dr. Honeyman (communicated by Prof. Macadam). (p. 77.)

"On the relation between the Solution Planes of Crystals and those of S[illegible]ing, and on the Mode of Development of Negative [illegible]former." By Prof. J. W. Judd, F.R.S. (p. 81.)

[illegible]horlaceous Rocks from near St. Austell." By F. H. [illegible]S.M. (p. 79.)

[illegible]schmidt exhibited some of the plates of a crystallo-[illegible]ch he is publishing.

Digitized by Google

EXCERPT MINUTES OF COUNCIL MEETING

Held at the Museum, Jermyn Street, Jan. 11th, 1887.

The following gentlemen were elected—

A. Pringle, M.A.
G. T. Prior, B.A.
J. M. Thomson, F.C.S.

Reported the death of Dr. E. H. Furuhjelm, of Helsingfors.

EXCERPT MINUTES OF COUNCIL MEETING

Held at 116 Victoria Street, April 4th, 1887.

The following gentlemen were elected—

F. W. Peard, of Natal.
Prof. A. H. Chester, Hamilton Col. Clinton.

The audited Balance-Sheet for the year 1886 was submitted and ordered to be printed (p. xiv.).

GENERAL MEETING.

Held at the Museum, Jermyn Street, Jan. 11th, 1887.

L. Fletcher, M.A., F.G.S., President, in the Chair.

The following papers were read:—

"On a Specimen of Meteoric Iron found at Youndegin, West Australia, in 1884." By L. Fletcher, M.A., President. (p. 121.)

"Additional Notes on the Felspar from Kilima-njaro." By L. Fletcher, M.A., and H. A. Miers, M.A. (p. 131.)

Professor Bonney said that it was very satisfactory to find that a small collection of rock fragments made by a traveller, who did not profess to be a geologist, had contained specimens of such interest. The rocks which he had examined from Kilima-njaro[1] did not, as far as he could ascertain with the microscope, contain any nepheline, though of course it would not be safe to draw a general inference from that, seeing that the collection was a small one, and Kilima-njaro a very large mountain. The rocks which he had examined were varieties of augite-andesite, most of them very vitreous,—dark brown glasses,—probably belonging to the more basic side of that group of rocks. These felspar crystals occur in a base of browned glass, containing minute microliths of felspar, with

[1] Described in *Report of Brit. Assoc.* for 1885 (Aberdeen), p. 682.

Digitized by Google

occasional small vesicles; their exterior is somewhat corroded by the glass which is occasionally present as inclusions. Mr. Johnston had collected the specimens on the central ridge of Kilima-njaro (at 14,000 ft.), on Kimawenzi (15,000 ft.), and at the base of Kibo (14,000 ft.). The only non-volcanic specimen in the collection was a bit of a quartz crystal collected in a stream valley on the mountain at about 8,000 feet.

Professor Judd stated that he had seen the same structure as that described by Mr. Miers, as occurring in the Kilima-njaro felspar, in a very fresh example of the felspar in the Norwegian "Rhomben-porphyr." It did not appear to be a *true* "microcline" structure, though it showed some peculiar analogies with it.

"On the Occurrence of Greenockite in a New Locality." By Prof. M. F. Heddle, F.R.S.E. (p. 138.)

"Note on a Form of Calcite from Heilim, in Sutherland." By Prof. M. F. Heddle, F.R.S.E. (p. 138.)

"Note on the Occurrence of Bismutite in the Transvaal." By H. Louis, F.I.C. (p. 139.)

"Note on Celestine Crystals from Gloucestershire." By R. H. Solly, F.G.S. (p. 142.)

"Note on Apatite Crystals from Cornwall." By R. H. Solly, F.G.S. (p. 141.)

"Note on the presence of Lead in Calcite from the Leadhills District." By J. Stuart Thomson. (p. 148.)

"On the Use of the Gnomonic Projection." By H. A. Miers, M.A. (p. 145.)

Professor Judd exhibited a specimen of the new mineral "Awaruite," discovered by Prof. Ulrichs, which was a terrestrial alloy of Nickel and Iron (Ni_2 Fe), being Nickel 67.63 per cent., and Iron 31.02 per cent., and which proved to be identical with the Octibbeha meteorite. Prof. Bonney remarked that the mineral occurred in an olivine sand, derived no doubt from peridotite rocks.

Colonel McMahon exhibited a sapphire from the Himalayas, which he thought some of the members might like to see, as it was of well-defined crystalline form, and showed well the characteristic habit of the Himalayan mineral. He regretted that he could not give the members

Digitized by Google

much information about the Himalayan sapphires. They came from the south-east portion of the territories of the Maharaja of Kashmir, called Padar, or Padam, on the borders of Zanskar—a particularly inaccessible corner of the Himalayas. As far as he could learn, a landslip revealed a vein of blue and white corundum in crystalline rocks in the year 1880-81. At first no importance was attached to the find, as the villagers thought the mineral was quartz, and valueless. Colonel McMahon was within about 30 miles of the place in September 1881, but heard nothing of the find at the time. As soon as the value of the mineral became known the Maharaja of Kashmir sent troops to the spot; caused the bridges leading into the valley to be broken down; and put a stop to any English or native traveller visiting it. Hence no geologist had been able to inspect the locality. He believed that the vein had since been worked out; but he saw no reason why similar sapphire veins should not be discovered hereafter in adjoining parts of the Himalayas.

GENERAL MEETING.

Held at the Museum, Jermyn Street, May 10th, 1887.

L. Fletcher, M.A., President, in the Chair.

The following papers were read :—

"Microscopical Studies on some Eruptive Rocks from the Caucasus and Armenia." By Dr. Hjalmar Gylling. (p. 155.)

"Note on some Specimens of Glaucophane Rock from the Ile de Groix." By Rev. Prof. T. G. Bonney, LL.D. (p. 150.)

"Note on Francolite." By F. H. Butler, M.A. (p. 164.)

"On the Crystalline Form of Kreatine."[1] By the President.

"On a Granite containing Andalusite, from the Cheesewring, Cornwall." By J. J. H. Teall, M.A., F.G.S. (p. 161.)

"On the Meteoric Iron seen to fall in the District of Nejed, in Central Arabia, in the Spring of 1865."[1] By L. Fletcher, M.A., President.

Prof. Judd exhibited some specimens and sections of Tabasheer, and other forms of Opal.

[1] Will appear in the next Number.

Digitized by Google

Mineralogical Society—Abstract of Receipts and Payments from 1st January to 31st December, 1886.

RECEIPTS.

	£	s.	d.
Balance from year 1885	15	1	0
Subscriptions for current year	79	14	0
,, Arrears	4	4	0
Entrance Fees and Life Composition	17	16	6
Sale of Publications	17	15	6
Dividends on Stock	5	16	1
Prof. Bonney :—Payment on Plate I, Vol. VII.	3	3	0
R. H. Solly :—Extra Copies	1	13	6
Dr. Heddle :—Payment of charge on Cheque	0	0	6
	£145	4	1

PAYMENTS.

	£	s.	d.
Printing	72	9	9
Illustrations	16	19	0
Expenses of Meetings	5	13	6
Editorial and Clerical Expenses	12	12	0
Postages, Parcels, &c.	8	17	0
Investments	13	16	1
Advertisements	0	14	6
Charge for keeping Stock of Publications and Insurance	5	9	0
Stand for Box containing Records	0	16	9
Balance	8	16	6
	£145	4	1

Examined and compared with the vouchers and found correct. (Signed)

BENEDICT KITTO,
F. W. RUDLER, } Auditors.

LIABILITIES.

	£	s.	d.
Editorial Expenses, 1886	10	10	0
Clerical ,, ,,	6	6	0
Williams & Strahan, Printing, &c.	15	13	0
S. Miller—Illustrations	1	15	0
Advertisements	0	5	0
Museum of Practical Geology, Gas, &c.	0	13	6
Excess of Assets over Liabilities	265	5	6
	£300	7	11

ASSETS.

	£	s.	d.
Subscriptions for 1886 unpaid	29	2	0
,, 1885 ,,	14	14	0
,, 1884 ,,	5	5	0
Entrance Fees unpaid	2	2	0
New 3 Per Cents. £204 8s. 3d. at 101¼	206	19	4
Stock of Publications (average yearly sale)	20	1	5
Simpkin & Co., Sale of Publications	12	17	8
Sale of Publications by Office—unpaid	0	10	0
Cash in hand and at the Bank	8	16	6
	£300	7	11

Examined and compared with the vouchers and found correct. (Signed)

ROBERT H. SCOTT,
General Secretary.

Digitized by Google

MINERALOGICAL SOCIETY..

DONATIONS FROM JULY 1ST TO DEC. 31ST, 1886.

The Fifth Annual Report of the United States Geological Survey, by J. W. Powell; Bulletin of the U. S. Geological Survey, Nos. 24 to 29; and Monograph on the Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. By Robert P. Whitfield.
Presented by the United States Geological Survey.

Proceedings of the Academy of Natural Sciences of Philadelphia. Part I., Jan. to March 1886. Presented by the Academy.

The American Journal of Science; current numbers. Presented by the Editors.

The American Chemical Journal for August and October. Presented by the Editor.

Notes on the Peridotite of Elliot Co., Kentucky, by J. S. Diller; and on Turquois from New Mexico, by F. W. Clarke and J. S. Diller.
Presented by J. S. Diller, Esq.

On the Brookite from Magnet Cove, Arkansas, by Edward S. Dana; and on two hitherto undescribed Meteoric Stones, by E. S. Dana and S. L. Penfield.
Presented by Professor E. S. Dana.

Observations on Volcanic Eruptions and Earthquakes in Iceland within historic times. By George H. Boehmer. Presented by the Author.

Descriptive Catalogue of a Collection of the Economic Minerals of Canada. By the Geological Corps; A. R. C. Selwyn, Director.
Presented by the Geological Survey of Canada.

Catalogue of Geological Exhibits in the New Zealand Court, Colonial and Indian Exhibition. By Dr. James Hector, C.M.G., F.R.S.
Presented by the Geological Survey of New Zealand.

Report of the Mining Registrars of Victoria for the quarter ending 31st March, 1886.
Presented by R. T. Litton, Esq.

Report of Committee of Management of the Technological, Industrial and Sanitary Museum of New South Wales for 1885. Presented by the Committee.

President's Address to the Royal Society of New South Wales. By Professor A. Liversidge, F.R.S. Presented by the Author.

Transactions of the North of England Institute of Mining and Mechanical Engineers. Vol. XXXV. Parts 3 and 4. Presented by the Institute.

Proceedings of the Bristol Naturalists' Society. New Series, Vol. V. Part I.
Presented by the Society.

The Naturalist: current numbers. Presented by the Editor.

The Moloch of Paraffin. By Charles Marvin. Presented by the Author.

Annalen des k.-k. naturhistorischen Hofmuseums, Wien. Redigirt von Dr. Franz Ritter von Hauer. Band I. Nos. 3 and 4. Presented by the Editor.

Jahrbuch der k.-k. geologischen Reichsanstalt, Wien: Band XXXVI. Heft 2 and 3. Verhandlungen, Nos. 8 to 14. 1886. Presented by the Institute.

Mineralogische und petrographische Mittheilungen: von G. Tschermak. N. F., Bd. VII. Heft VI.; Bd. VIII. Heft. I. and II. Presented by the Editor.

Zeitschrift für Naturwissenschaften, Folge IV., Bd. V. Hefte 1-6.
Presented by the Editors.

Digitized by Google

Vorträge und Mittheilungen. Von G. vom Rath. Presented by the Author.

Mineralogische Notizen. 1886. Von G. vom Rath. Presented by the Author.

Worte der Erinnerung an Prof. Dr. A. von Lasaulx. Von G. vom Rath. Presented by the Author.

Seccion de Minas del Departamento de Obras públicas de la República Argentina. Primer Año, 1885. Presented by L. Albertini.

Beobachtungen an Stassfurter Vorkommnissen; von Dr. O. Leudecke. Ueber ein neues Vorkommen von Bloedit-krystallen im Leopoldshaller Salzwerke: Von Dr. O. Leudecke. Presented by the Author.

Ackererde und Untergrund von Franzenshütte. Von Prof. Dr. Carl Schmidt. Presented by the Author.

Zur Dyas in Hessen. Von H. B. Geinitz. Presented by the Author.

Verhandlungen des deutschen wissenschaftlichen Vereins zu Santiago. Heft. 3. Presented by the Society.

Bulletin de la Société Française de Minéralogie. Tome IX. No. 5. Presented by the Society.

Sur la Kirwanite et la Hullite; Propriétés optiques de l'Arséniosiderite; Propriétés optiques de quelques minéraux; Examen optique de l'hydrotéphroite et l'anthophyllite hydratée; Propriétés optiques de la Grünerite; Du Chloritoïde; Etude minéralogique du gabbro à anorthite de Saint-Clément; Sur un minéral probablement nouveau dans le guano du Perou; Identité de la Dréelite et de la Barytine; Propriétés optiques de la Warwickite et de la Withamite; Pléochroisme de la Thulite; Contributions à la connaissance des propriétés optiques de quelques minéraux; Sur l'albite des Pegmatites de Norwège; Note sur les Anthophyllites; and Déscription d'une Variété de Carphosidérite. All by M. A. Lacroix. Presented by the Author.

Publications de l'Institut Royal Grand Ducal de Luxembourg. Tome XX., 1886. Presented by the Institute.

Atti della Reale Accademia dei Lincei. 1886; Fasc. 1 to 9, 1st Semestre, 1887. Presented by the Academy.

Atti della Società Toscana di Scienze Naturali: Processi verbali, Vol. V. pp. 80-118. Presented by the Academy.

Bolletino del R. Comitato Geologico d'Italia, Nos. 5-8, 1886. Presented by the Commission.

Annales de la Sociedad Cientifica Argentina. Marzo-Julio, 1886. Presented by the Society.

Digitized by Google

EXCERPT MINUTES OF COUNCIL MEETING

Held at the Museum, Jermyn Street, Oct. 25th, 1887.

The Draft Report of Council for the past Session was adopted.

The following days were fixed for the Meetings in the Session 1887-8.

January 10th, 1888.
May 8th.
October 30th, Anniversary.

It was resolved, "That in addition to three Meetings to be held in England, a Meeting be held in Scotland, provided a sufficient number of Members signify their intention of being present."

ANNIVERSARY MEETING.

Held at the Museum, Jermyn Street, Oct. 25th, 1887.

L. Fletcher, M.A., F.G.S., President, in the Chair.

The following Report of Council was read and adopted:—

REPORT.

The Balance Sheet, which appeared in No. 34 of the Journal, showed a healthy condition of the Society, as to its finances. The excess of Assets over Liabilities was, at the commencement of the year, £265 5s. 5d., being an increase of £24 1s. 2d. during the twelve months. The net expenditure on the Journal was £74 12s. 3d., as compared with £71 8s. 5d. in 1885.

The elections to the Society during the year have been five. The Council have to regret the loss by death of Dr. H. Furuhjelm, Inspector of Mines for Finland, of whom an obituary notice by Dr. H. Gylling will appear in the next number of the Journal. The resignations during the year have been seven, while the names of three gentlemen have been removed in accordance with Rule XXX. (for non-payment of subscriptions).

Two meetings have been held since the last anniversary—on January 11th and May 10th, 1887 respectively: they were held as usual in the Museum of Economic Geology, by kind permission of the Director-General of the Geological Survey.

Digitized by Google

Two numbers of the Journal have appeared during the year ; No. 33 contained a most interesting paper by Prof. Judd, F.R.S., on the theory of Schillerization, while the chief feature of the last part has been the account, by our President, of the Youndegin Meteorite from West Australia, in which he has been fortunate enough to re-discover the cubic crystals of graphitic carbon, which had been announced by Haidinger, in 1846, as present in the Arva Meteorite, and were regarded by him as of pseudomorphous origin.

The following were elected Officers and Council for the ensuing year :—

President.	L. Fletcher, M.A., F.G.S.
Vice-Presidents.	Rev. S. Haughton, M.D., F.R.S.
	W. H. Hudleston, J.P., M.A., F.R.S.
Council.	A. Geikie, LL.D., F.R.S.
	Rev. H. Gurney, M.A.
	Hugo Müller, Ph.D., F.R.S.
	Rev. W. W. Peyton.
	Prof. J. W. Judd, F.R.S.
	Prof. E. Kinch, F.C.S.
	Prof. W. Ivison Macadam, F.C.S.
	J. J. H. Teall, M.A., F.G.S.
	Prof. A. H. Church, M.A., F.C.S.
	Townshend M. Hall, F.G.S.
	Col. C. A. McMahon, F.G.S.
	J. Stuart Thomson.
Treasurer.	Rev. Prof. T. G. Bonney, M.A., D.Sc., F.R.S.
General Secretary.	R. H. Scott, M.A., F.R.S.
Foreign Secretary.	T. Davies, F.G.S.
Auditors.	B. Kitto, F.G.S.
	F. W. Rudler, F.G.S.

The thanks of the Society were voted to the retiring Members, Messrs. Danby, Dobbie, Prof. Lewis, and Dr. Burghardt.

The following papers were read :—

"On a Meteoric Iron, containing crystallised Chromite, found in Greenbrier County, West Virginia, about the Year 1880." By the President. (p. 183.)

"On the Nature and Origin of Clays." By J. H. Collins, F.G.S. (p. 205.)

"Note on the occurrence of what may prove to be a new Mineral Resin." By J. Stuart Thomson. (p. 215.)

Digitized by Google

"On a variety of Glaucophane from the Val Chisone (Cottian Alps)." By Rev. Prof. T. G. Bonney, F.R.S. (p. 191.)

"On the discovery of Leucite in Australia." By Prof. J. W. Judd, F.R.S. (p. 194.)

"On Proustite containing Antimony." By H. A. Miers, M.A., and G. T. Prior, B.A. (p. 196.)

"Description of a new Student's Goniometer." By H. A. Miers, M.A.

"On the occurrence of Rutile Needles in Clays." By J. J. H. Teall, F.G.S. (p. 201.)

The following specimens were exhibited :—

Cubic Crystals of Graphitic Carbon from the Meteoric Iron of Youndegin.

Crystals of Chromite from the Meteoric Iron of Greenbrier County.

Opal from Queensland.

Large Cubic Crystal of Fluor from Switzerland.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

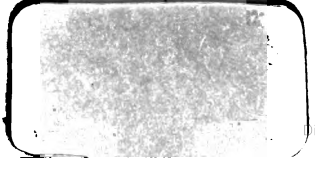
Digitized by Google

BRANNER GEOLOGY LIBRARY
549.05
.1166
7
1886-07

Stanford University Libraries
Stanford, California

Return this book on or before date due.

NON-CIRCULATING



Digitized by Google